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FINANCIAL AND ECONOMIC REVIEW

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in Hungary

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Communication: The Great Catchup

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The Status and Development of Financial Literacy in Hungary*

Eszter Hergár  – *Levente Kovács*  – *Erzsébet Németh* 

This essay provides an overview of the measures implemented in the last ten years to improve financial literacy and awareness, presenting the steps taken by institutions, civil organisations and the government to promote and develop financial literacy and awareness, the specific topics addressed and the degree of success. Comparative international surveys indicate an improvement in the public's financial awareness, mainly in terms of financial knowledge, but further progress is needed in the area of financial attitudes and the application of skills.

Journal of Economic Literature (JEL) codes: A13, D12, G51, G53, I2

Keywords: financial literacy development programmes, financial education, financial awareness, Hungary

1. Introduction

After the financial crisis erupted in 2008, most countries realised that the development and financing of financial literacy must be implemented through coordinated, transparent, quality-assured measures enacted by the state and the central bank (*Jakovác – Németh 2017; Csiszárík-Kocsir et al. 2021; Bárczi – Zéman 2015*). Numerous domestic studies also made it clear that financial awareness cannot be developed without the participation of the public sector. As the development of financial literacy is in the common interest of all economic and civil actors, it requires the cooperation of the state, credit institutions, businesses and civil organisations. This essay reviews the changes in the status and development of domestic financial literacy over the last ten years, together with the measures taken at the level of government and law, institutions and civil organisations. The strategy for developing the public's financial awareness and the first accredited

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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textbook in financial literacy were published in 2017 and were followed by many subsequent textbooks, workbooks and electronic learning materials. The National Core Curriculum has designated economic and financial education among the key competencies to be developed in school; however, as an independent subject, financial and economic skills are not typically present in the curricula of public education institutions. The results of research on the overview of financial literacy programmes show that while the volume of training, the number of training programmes and the number of participants had increased by about threefold by 2020 compared to 2016, most of these programmes were aimed at the school-age group. PÉNZ7 (Money Week) is a programme of outstanding importance for the development of financial literacy, which supports the development of financial awareness in schools in the context of extracurricular lessons and other playful, interactive events.

2. An overview of the literature

2.1. The concept of financial literacy – knowledge, skill, attitude and behaviour

The term ‘financial literacy’ was coined in the early 1900s (Kovács *et al.* 2014). Several definitions of financial literacy are used in the literature, depending on the interpretation (Pál 2018; Kovács – Terták 2019). Among other things, the focus can be on understanding financial processes or the ability to make financial decisions. The literature does not have a uniform definition of financial literacy. Used as a synonym for financial awareness, the term ‘*financial literacy*’ can be traced to the English-language sources, which it was adopted from.

Several studies define financial literacy primarily on the basis of financial knowledge and skills. According to Dutch researchers, financial literacy is connected to having knowledge and understanding of complex financial products. Mak – Braspenning (2012) and Suganya *et al.* (2013) write that financial literacy is the set of knowledge and skills that can be used to achieve balance in a person’s finances, with the purpose of ensuring financial prosperity. The concept of financial literacy includes financial knowledge, know-how, skills and experience (Béres – Huzdik 2012). According to Plakalovic (2012), in addition to the ability to make decisions, it also includes the ability to communicate and react. After reviewing hundreds of studies, Remund (2010) stated that financial literacy includes the ability and confidence with which individuals can manage their own personal finances. The author summarised the common points of several definitions applied to financial literacy. Each of the definitions he examined contains elements that can be classified into five main categories – a good grasp of financial services, the ability to manage money, the ability to communicate, the ability to make decisions and the management of personal finances.

In her research, *Huston (2010)* examined 71 studies, of which more than 50 failed to provide a definition for the concept of financial literacy. The survey also draws attention to the fact that, in the remaining cases, eight different definitions were formulated, while about half of the studies did not separate financial knowledge from financial literacy.

Other studies and analyses point out that it is necessary to examine not only the financial knowledge and skills of individuals, but also their attitudes, behaviour and traits, i.e. the financial literacy and awareness of consumers.

Most experts, as well as the strategy adopted in 2017 to develop the public's financial awareness, use the definition provided by OECD¹ (*Atkinson – Messy 2012*), which states: “financial awareness is a skill that enables the efficient growth, monitoring and use of financial resources in a way that contributes to the strengthening of the well-being and economic security of individuals, their family and their business.”

According to the Magyar Nemzeti Bank (central bank of Hungary, MNB) and its partners, financial literacy “(...) is a level of financial knowledge and skills that enables individuals to identify the basic financial information necessary for making conscious and prudent decisions, obtain and interpret this information, and then, before making decisions, use it for assessing the potential financial and other consequences of their decisions.”²

According to *Amagir et al. (2020)*, the main characteristics of financial literacy are insight, knowledge and behaviour, as well as attitude and confidence. In their opinion, all of these have an impact on financial decisions. As such, the development of financial knowledge and awareness can influence macroeconomic, monetary and budgetary processes, as well as the proper functioning of financial markets, i.e. the effectiveness and competitiveness of the financial system as a whole.

Financial literacy is thus a complex phenomenon without a uniform definition. However, most definitions make reference to a level of competency that allows for the use of sources of financial information, the acquisition, organisation and comparison of such information, as well as the ability to make individual decisions. In addition, financial literacy includes knowledge, attitude and calculation skills. It is easy to see that a complex model is required for analysing financial literacy.

¹ OECD = Organisation for Economic Co-operation and Development

² A pénzügyi tudatosság fejlesztése segíti a családok anyagi biztonságát is (The development of financial awareness also helps the financial security of families). Press release, Magyar Nemzeti Bank. <https://www.mnb.hu/sajtoszoba/sajtokozlomenyek/2020-evi-sajtokozlomenyek/a-penzugyi-tudatossag-fejlesztese-segiti-a-csaladok-anyagi-biztonsagat-is>. Downloaded: 12 December 2023.

2.2. Assessing and evaluating the transfer of knowledge

A significant part of the domestic research has studied financial literacy in relation to various social and occupational groups. For example, *Győri (2018)* examined the financial vulnerability of Hungarian small and medium-sized enterprises; *Garai-Fodor (2023)* examined the financial awareness of consumers; *Kovács et al. (2021)* examined the financial literacy of high school students; *Sági et al. (2020)* examined the financial awareness of households; and *Kálmán et al. (2021)* explored the impact of the pandemic on the financial security of higher education students in economics. These key studies are also important for providing the scientific background of programmes aimed at developing financial literacy. Furthermore, domestic studies examining financial behaviour related to personality, attitude or culture are of particular interest as well. *Németh et al. (2016)* studied financial personality types based on a financial personality test that they created, while *Pintér et al. (2021)* examined the impact of digitalisation and fintech on the financial decisions of young people. In their investigation of correlations between financial attitude and external and internal control, *Mihály et al. (2014)* identified the internal control attitude as a protective factor. In their latest study, *Hegedűs and Lentner (2024)* examined the cultural dimensions of Geert Hofstede and the correlations of financial literacy.

In respect of the overview and evaluation of the development of financial literacy in Hungary, the most informative studies are those that evaluate the objectives, participants, quality assurance, methodology and, last but not least, the effectiveness of programmes aimed at the development of financial literacy.

Some of the fundamental questions in studies examining training courses organised with the purpose of developing financial literacy are whether they are effective, whether they have a meaningful impact on the financial literacy and behaviour of individuals and groups, whether it is formal education or demographic and social indicators that have a defining role in this respect, and whether, based on the findings, it is worth investing significant social resources in financial literacy training.

Kovács – Pásztor (2022) examined the situation of financial literacy in Europe compared to other regions of the world, and the kind of associated development programmes individual European Union countries are launching or have launched. The findings of international and domestic studies vary widely. Results show that increasing financial literacy may translate into growth potential. Numerous studies have found a significant correlation between the level of financial knowledge, previous participation in financial development, and financial behaviour and attitude, establishing that those receiving financial training are more frugal, have plans for their retirement years and are less prone to accumulate debt (*Bernheim et al. 2001; Lusardi – Mitchell 2014; Hilgert et al. 2003; Stango – Zinman 2007; Van Rooij et al. 2011*).

In their study, *Czeglédi et al. (2016)* examined the transfer of business knowledge to students in Hungarian higher education. Their analysis found one hundred and one subjects that touched upon business knowledge, but without making use of interactive methods, such as role playing, case studies or simulations. Also, they found that entrepreneurial experiences are barely integrated into higher education. All of this is different from, for example, the methodology of business courses offered in the USA.

An internationally cited Hungarian study (*Béres et al. 2013; and Luksander et al. 2014*) examined, among other things, the factors determining the level of financial knowledge of students in Hungarian higher education. Their findings shed light on the fact that the financial knowledge of those who had received financial and economic training in secondary school was not significantly higher than that of those who had not received such education. At the same time, the study revealed that the examined socio-demographic factors, such as age, gender, the level and field of education, knowledge, life situation and ability to lead an independent lifestyle significantly influenced the level of financial awareness.

The important study by *Amagir et al. (2018)* compared the results of research exploring the relationship between financial training and financial behaviour. The authors found a positive correlation between financial education at school and the financial knowledge and attitudes of students.

Carlson (2020) examined the correlations between real financial knowledge and financial knowledge that can be obtained in public education among Americans aged 18–24. According to the findings, certain demographic factors, such as ethnicity or gender, are more important from the point of view of financial literacy than high school education. *Van Rooi et al. (2011)* also emphasised the correlations between financial knowledge and social background variables. According to them, most research results seem to support that the level of financial knowledge correlates with gender, age and education. In other words, the studies shed light on the fact that financial education is effective only if it takes into account the needs of individual groups.

These studies also clearly emphasise that financial training does not always have a positive result, and that the examination of the variables behind its effectiveness or failure is, therefore, the key to the success. It is necessary to examine, among other things, the purpose, target group, duration, topics and teaching materials, the availability, quality and quality assurance of the teaching materials, the training and preparation of the instructors, the adequacy of the teaching methods, and whether the organisers of the programme believe that the developments were indeed effective.

3. State involvement in the development of financial literacy

3.1. Creating the strategic foundations

In order to mitigate the risks arising from the lack of skills and knowledge necessary for financial decisions, many organisations have launched programmes aimed at developing financial literacy, executed – often in cooperation – by both state and non-state actors, typically operating in the financial market. These programmes include training courses, studies, surveys, competitions, consulting, documents and applications available on the Internet, etc. Important state actors are playing an increasingly active role in the development and spreading of financial knowledge and literacy, such as the Magyar Nemzeti Bank, the Ministry of Human Resources (EMMI), the Ministry of National Economy (NGM), the State Audit Office (SAO), the Ministry of Finance (PM), ministerial background institutions and educational institutions.

In respect of improving financial literacy at the level of society, one major step forward came in 2017 when the Government adopted a strategy for developing the financial awareness of the population (*Ministry of Finance 2017*); additionally, the first accredited financial culture textbook – initially for secondary school students, and then for 7th and 8th-grade students – was published in the same year.

The strategy defined an action plan, specific tasks and deadlines for the period between 2017 and 2023. It also assigned index numbers to the objectives and prescribed periodic assessments to measure achievement.

The strategy laid out the following seven main objectives:

- I. creating and implementing the framework of real financial education within the public education system;
- II. strengthening the foundations of conscious financial behaviour and the financial stress tolerance of households;
- III. creating an approach that promotes prudent financial decisions, as well as establishing and promoting institutions that support conscious financial consumer behaviour;
- IV. strengthening the public's approach to saving for retirement;
- V. increasing access to financial products and basic services, and increasing financial integration;
- VI. encouraging the use of modern, cash-saving payment instruments;
- VII. supporting prudent borrowing.

The measures were selected based on the findings of OECD's 2015 questionnaire-based survey (*OECD 2016*). On the way towards achieving the objectives laid out in the strategy, it was an important milestone when, in the autumn of 2017, the instruction of financial and entrepreneurial skills as separate subjects began in secondary-level vocational schools (now known as technical schools).

3.1.1. Establishing the legal framework

Even before 2016, the Hungarian state had established certain legal frameworks to ensure the organisation and transparency of the development of financial literacy and awareness.

- a) In order to enforce consumer rights related to financial service activities, it is possible to initiate a free financial consumer protection procedure at the Magyar Nemzeti Bank, and the complainant can also request the intervention of the Financial Arbitration Board in order to settle the dispute.
- b) Based on the law defining its operation and activities, the MNB has been involved in strengthening and spreading financial literacy since 2013, being bound by law to use part of its income for this purpose, as well as for developing financial awareness and promoting related objectives, in particular the development of the associated educational and research infrastructure.
- c) A priority area of the State Audit Office's social responsibility commitment was the development of financial literacy, which was recognised and supported by Parliament in a resolution in 2014. In November 2022, the SAO transferred its responsibilities in the field of financial awareness and literacy to the Money Compass Foundation.³
- d) A Financial Rights Commissioner has been appointed since 2012 in order to enforce consumer rights related to financial service activities.⁴

Since 2017, the government policy aimed at strengthening financial awareness has been managed by the State Secretary of the Ministry of Finance responsible for financial affairs. In 2022, after the elections, the task was transferred to the work organisation of the Minister of Economic Development, and subsequently, on 1 January 2023, to the independent Ministry of Economic Development.

As the 2013 Government Decree on the National Core Curriculum⁵ states, "*New generations must have useful knowledge about the economic and financial institutions and processes that define the world economy, the national economy,*

³ https://www.asz.hu/files/ASZ_orzaggyulesi_beszamolo_2023.pdf

⁴ Based on Section 41 of Act CLV of 1997 on Consumer Protection.

⁵ Government Decree 110/2010 (VI. 4.) on the issuance, introduction and implementation of the National Core Curriculum

businesses and the life of households.” The law specifies economic and financial education as one of the development areas, educational objectives and key competences to be developed, in order for “(...) students to recognise their responsibility related to value-creating work, the rational management of assets, as well as the world of money and consumption.” However, while stressing the importance of teaching the subject, the law fell short of integrating economic and financial education horizontally and comprehensively at the level of the subjects in relation to individual areas of literacy or the compulsory core curricula, and discussed it separately for certain areas of literacy and subjects.

The government decision on the adoption of the strategy (December 2017)⁶ requested the Minister of Human Resources to take into account the contents of the strategy aimed at developing financial awareness for the purpose of developing professional proposals for the renewal of the National Core Curriculum. In addition, it required that the implementation and promotion of training that takes into account the age and previous experience of the students and stipulates that practical economic and financial competences be included in the curricula. However, the amendments to the government decree⁷ did not affect economic and financial education until as late as February 2020. The regulation that was finally completed⁸ gave the green light for incorporating the transfer of financial and business knowledge into academic learning time allotted for custom subjects. This part of academic time is available to primary school students between 1st and 8th grade and secondary school students between 9th to 10th grade at two hours per week, to 11th-grade students at four hours per week and to 12th-grade students at five hours per week. In spite of the fact that, according to the action plan of the strategy, financial awareness needs to be established in public education at the primary school level, financial education is only taught as a compulsory subject in technical schools.

With regard to the development of education, the existence and availability of teaching materials is a key issue. Significant progress has been made in this area. In respect of curriculum development, the work of the Financial Compass Foundation is of major importance. Students can now study using textbooks, workbooks and electronic study materials published by the Foundation starting from the 3rd grade of primary school until the graduation exam.⁹ With the support of the Magyar Nemzeti Bank, secondary schools received 385,000 copies of the workbook entitled “Történelem és pénzügyek” (History and Finances) and the exercise book

⁶ The provision is contained in Section 2 of Government Decree 1919/2017. (XII. 8.) on the adoption of a strategy aimed at the development of the financial awareness of the population.

⁷ The government decree was amended four times prior to 2020, last time with effect from 1 January 2018.

⁸ Government Decree 5/2020 (I. 31.) on the amendment of Government Decree 110/2012 (VI. 4.) on the issuance, introduction and implementation of the National Core Curriculum

⁹ <https://penziranytu.hu/ingyenes-tankonyvvel-segiti-penzugyi-nevelest-az-iskolakban-penziranytu-alapitvany-0>

entitled “Számoljunk a befektetésekkel” (Calculating Investments). In September 2020, all students starting the 9th grade received the mathematics exercise book free of charge, while those preparing for secondary school graduation and their teachers received the History and Finances workbook. Also free of charge, the textbook and workbook entitled “Küldetések a pénz világában” (Missions in the World of Money) were provided to primary school students, and the book entitled “Íránytű a pénzügyekhez” (A Compass for Finances) was provided to secondary school students. In the 2020/2021 academic year, schools ordered 220,000 copies of the environmental studies and mathematics workbooks that also include financial knowledge. In the three years that have passed since then, the number of textbooks and workbooks containing financial knowledge has increased by 50 per cent, and the number of members in the Financial Compass School Network has doubled. Supporting the development of financial awareness, the workbook entitled “Állampolgárok pénzügyei” (Citizens’ Finances) was disseminated in 162,000 copies to Hungarian schools, intended for 8th and 12th-grade students. In addition, schools ordered nearly 545,000 copies of textbooks containing basic financial and management knowledge and workbooks including financial chapters. Thus, up to 700,000 copies of publications will be available to support the financial education of students in the 2023/2024 academic year.

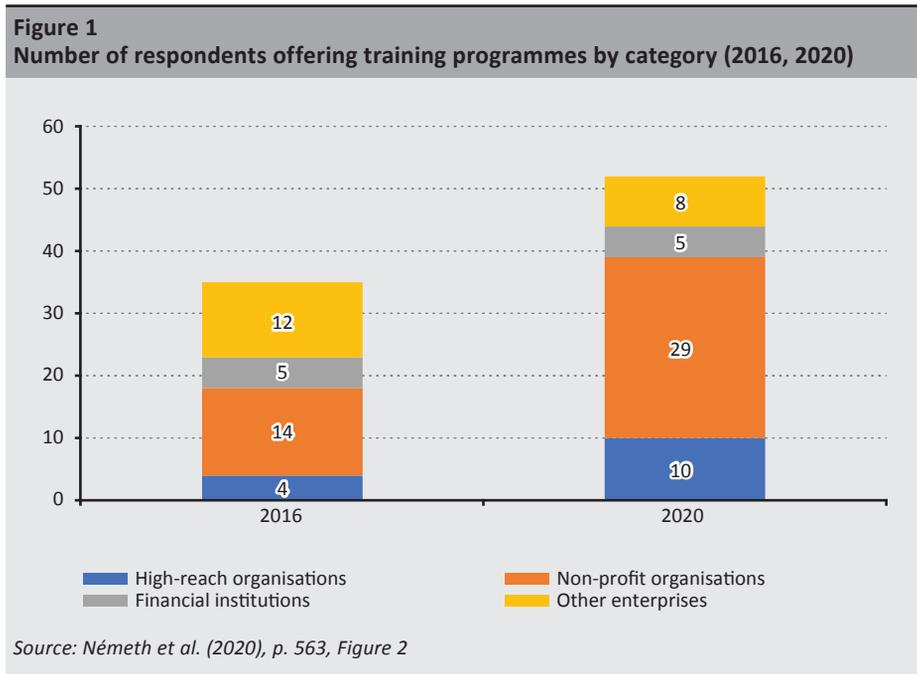
4. The role of civil society in the development of financial literacy

In 2016 and again in 2020, the State Audit Office evaluated the situation of the development of financial literacy in Hungary (Németh 2017; Németh et al. 2020). In the following, we present the main results of the research, with a focus on the history of the participation of civil society during the period reviewed. In addition, we look at the most important actors and discuss in detail the events and findings associated with the most influential event, the PÉNZ7 – Pénzügyi és Vállalkozói Témahét (Financial and Entrepreneurial Theme Week).

4.1. Organisations, trainings and programmes

The studies were intended to comprehensively map those involved in the development of financial literacy. In the context of the 2016 study, 35 organisations offering training programmes filled out the questionnaire. In the 2020 survey, 52 similar respondents were involved, representing an increase of almost 50 per cent.

Based on their general characteristics, the respondents can be classified into four combined categories. Of the 52 respondents offering training, 10 can be classified as high-reach organisations, 5 as financial institutions, 29 as non-profit organisations and 8 as other enterprises. Compared to 2016, 15 more foundations, associations or non-profit organisations, as well as 6 more organisations with a reach above 10,000 people (so-called high-reach organisations) were involved (Figure 1).

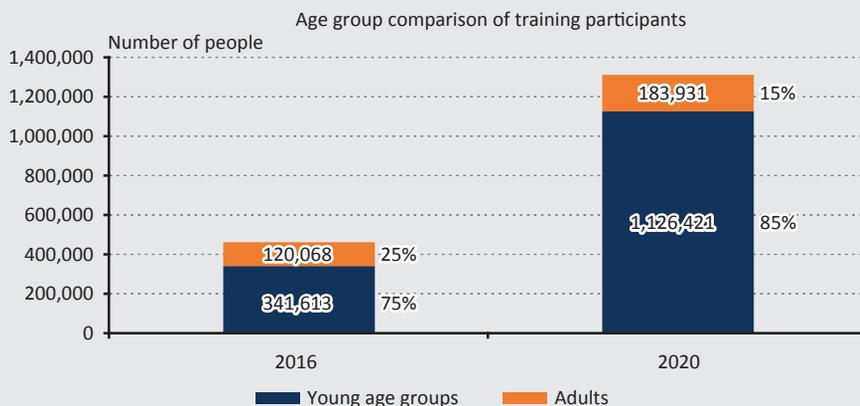


4.1.1. Participation in training

According to the findings of the 2020 study, financial literacy training courses were held for a total of 1,310,352 people between 2016 and 2020. This is a very significant improvement, as the number of people participating in the development of financial literacy almost tripled compared to the last similar survey, when a total of 461,681 participants had attended training courses in the four years prior. The results of the 2016 study indicated that the majority (75 per cent) of the groups targeted by the programmes consist of young people (students in public and higher education aged 6–25). In 2020, the proportion of those reached with the programmes was similar to the 2016 data, while the share of young people had increased to 85 per cent (Figure 2).

In addition, the study also showed that relatively few of the training courses organised for adults were aimed at groups that are financially vulnerable or that require special training, such as entrepreneurs, retired people or the unemployed.

Figure 2
Number of people and share of age groups reached by the courses (2016, 2020)

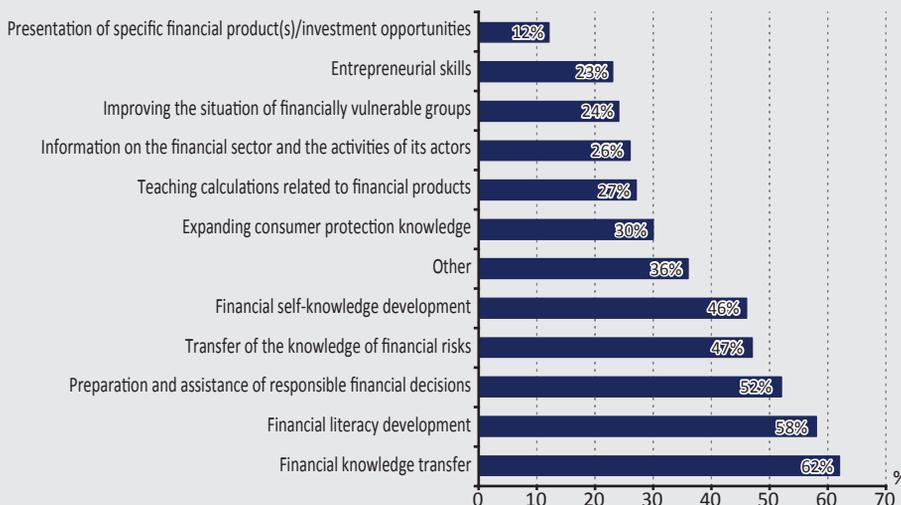


Source: Németh et al. (2020), p. 567, Figure 8

4.2. Objectives and major topics of the training courses

The order of training objectives was similar in case of both the 2016 and the 2020 surveys. In 2020, the most frequently cited objectives were general goals, such as “transferring financial knowledge” or “developing financial literacy” (Figure 3). It was a step forward that, compared to 2016, the share of the target indicated as “improving the situation of financially vulnerable groups” increased.

Figure 3
Objectives of training programmes (2020)

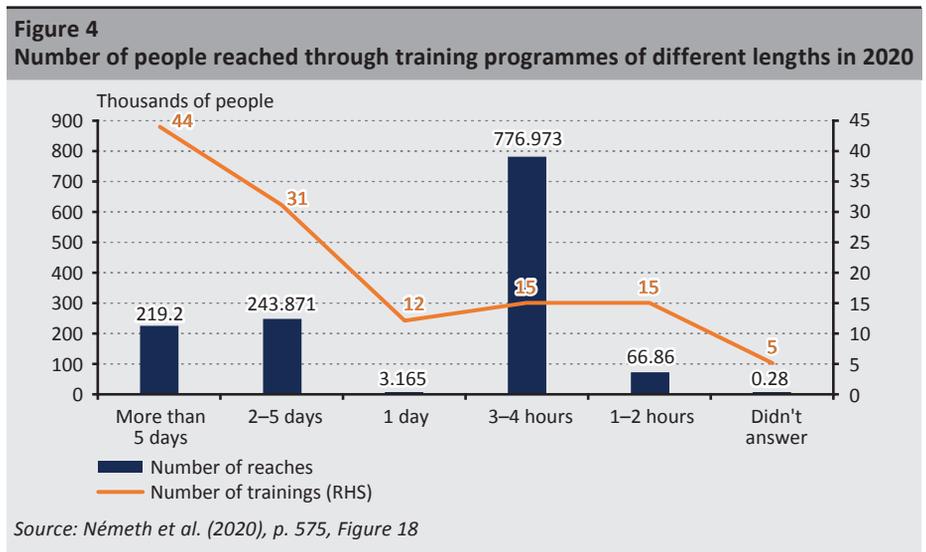


Source: Based on data by Németh et al. (2020)

Literature sources point out that the transfer of knowledge is effective if the training is tailored to the needs of the target groups (Cude 2010; Czeglédi et al. 2016). While in 2020 more programmes were aimed at financially vulnerable groups than before, most of the training courses offered for adults still failed to take into account the income situation and social background of the target groups. The programmes focused on developing financial awareness and frugality, and less on generating income. This shows that the training organisations realised that strengthening the public’s culture of financial self-sufficiency and transferring the associated knowledge are important goals.

4.3. Duration and quality assurance of training courses

Compared to the 2016 survey, the number of training programmes lasting 2 to 5 days or longer, and those lasting more than 5 days, increased significantly, while the proportion of short, 1- or 2-hour training programmes decreased. Researchers also examined the number of participants attracted by training programmes of different lengths (Figure 4).



Although the number of longer training courses increased significantly, around 60 per cent of the participants continued to participate in shorter, 3- or 4-hour programmes (Figure 4), and only 35 per cent of the participants were involved in longer training courses. Thus, the majority took part in training programmes with smaller group sizes. Most of the courses intended for students in public schools were shorter (1 to 4 hours). While short training courses may be suitable for attracting attention and imparting certain knowledge, the financial behaviour and attitudes cannot be efficiently shaped under such conditions.

The research findings indicate that the availability of training topics and teaching materials and the use of accredited educational materials did not improve significantly from 2016 to 2020. This is particularly worrisome in light of the fact that while accredited teaching materials were not widely available in 2016, this had changed by 2020 when a significant number of educational aids and textbooks were readily available. The results highlight the need to measure effectiveness and strengthen the professional quality guarantees offered for training courses.

5. PÉNZ7, the Hungarian programme with the highest reach

In 2015, the European Banking Federation (EBF) announced the first European Money Week at the initiative of Queen Maxima of the Netherlands (then only a princess), a former investment banker and OECD ambassador for financial literacy. The members of the EBF, that is, the European national banking associations, immediately joined this initiative, allowing it to debut as a pan-European event in its first year.

In Hungary, PÉNZ7 (Money Week) was launched in 2015 in cooperation with the Hungarian Banking Association (MBSZ) and the Money Compass Foundation. Later, the Ministry of Human Resources also joined in by initiating the integration of Money Week as a theme week into the academic year. Given the educational cooperation of commercial banks, the central bank and the government, Hungary's PÉNZ7 has become the most significant national financial theme week in Europe in terms of volume and proportions since its launch. In 2019, out of 170 countries, Hungary's theme week was the only one from Europe to be nominated for the "Excellence Award" at the Global Money Week event series. The organiser, Child and Youth Finance, intended the nomination and award as a way of acknowledging the work of those countries and organisations that represent a novel approach to the experience-oriented financial and entrepreneurial education of young people (Pintér 2020). The unwavering success of the theme week served as a further incentive for continued efforts to include both the financial part (from 2017) and the entrepreneurial part in the schedule of school years. By providing voluntary lecturers and preparing quality-assured teaching materials, the professional organisations support the schools in implementing their programmes at a high professional level.

The thematic PÉNZ7 is organised annually within the framework of a joint project. From 2017, EMMI, acting as the project manager, included the curriculum in the official schedule of academic years in the form of a theme week. As a result of PÉNZ7 becoming a public programme and the increasing recognition of the importance and necessity of financial literacy and strong government commitment, the circle of supporters has continuously expanded ever since. Starting from the 2022/2023 academic year, the programme has been implemented as a cooperation of six organisations. In addition to the initial coordinators, i.e. the Hungarian Banking Association and the Money Compass Foundation, the State Secretariat for Public Education of the Ministry of the Interior (formerly EMMI), the Ministry of Finance in charge of developing the government strategy for the development of financial

literacy,¹⁰ the Ministry of Economic Development and Junior Achievement Hungary Foundation are now included as project managers.¹¹

PÉNZ7 is aimed at primary and secondary school students. In the first year, 2015, nearly 90,000 students in about 650 schools took part in PÉNZ7 events. Strong, continuous growth was subsequently observed until the outbreak of the pandemic (*Table 1*).

	2015	2016	2017	2018	2019	2020	2021	2022	2023
Schools	650	788	1,117	1,249	1,235	1,208	1,100	1,029	1,118
Students (in thousands)	90	110	160	202	205	217	171.5	170	145
Teachers	1,000	1,278	1,376	1,645	1,737	1,725	1,974	1,688	1,664
Volunteers	200	256	405	438	694	901	700	459	510

Source: MBSZ data

The curriculum of theme weeks is determined by the joint decision of the organisers on the basis of current social challenges and along the lines of a well-defined educational strategy. *Table 2* summarises the topics of the series of programmes up to the present.

Summary table	
Financial topics (2015–2024)	Entrepreneurial topics (2017–2024)
2015	Family budget planning
2016	Savings and financial planning
2017	Smart banking & modern money management
2018	Smart loaning strategies
2019	Smart investments
2020	Financial security
2021	Conscious money management in the family – family budget planning
2022	Savings and financial planning
2023	Modern money management and financial security in cyberspace
2024	Financial life lessons

Source: MBSZ data

¹⁰ In 2017, the government adopted a comprehensive, 7-year national strategy for developing the public’s financial awareness, the aim of which is to increase the financial knowledge of the citizens of Hungary and to offer them a chance to acquire practical experience in managing their everyday finances.

¹¹ The entrepreneurial theme is coordinated by the State Secretariat for Economic Development and National Financial Services, in cooperation with the Junior Achievement Hungary Foundation. Thus, the theme week covers, among other things, everything from establishing a business to facing the challenges and making use of the opportunities that arise during its operation.

5.1. Regular events of PÉNZ7

Course organisers and the institutions dedicated to the development of financial literacy also provide a variety of additional programmes. Offering playful competitions and challenges, these programmes are intended to promote, among other things, financial inclusion, awareness of banking providers and services, the efficient and safe use of investment and savings opportunities, as well as key areas of insurance and cybersecurity (see *Annex* for details).

In the context of PÉNZ7, additional events and competitions are organised with the purpose of activating the creative energy and entrepreneurship of young people in the process of teaching them important knowledge and skills, such as solving business problems, developing entrepreneurial, financial and economic awareness, and promoting sustainability (*Table 3*).

	Events and topics	Goals and content
2023	<i>Innovation Challenge: Junior Achievement Hungary</i>	In online or traditional 2-day competitions, teams of secondary school students are invited to propose a solution to a real social or business problem.
2020	<i>Művészet és pénz (Art and Money)</i>	Művészet és pénz is an accompanying event initiated and organised by the Hungarian National Gallery.
2019	<i>MeseTÁRca (Purse of Fables)</i>	A video competition for young primary school students.
2019	<i>KÉPBEN VAGY? (ARE YOU GETTING IT?)</i>	The purpose of the competition, organised in connection with the Pénzügyi és Vállalkozói Témahét (Finance and Entrepreneurship Week), is to provide an opportunity for young people to demonstrate their understanding of what it means to be an entrepreneur.
2019	<i>Pénzügyi Adatvizuális Verseny (Financial Data Visualisation Competition)</i>	Intended for those who want to further develop their knowledge in the field of data analysis and visual data discovery.
2019	<i>Cetelem Quiz at Money Week!</i>	The objective is to draw the attention of young people to everyday financial and entrepreneurial awareness with professional programmes, special events and playful competitions.
2018	<i>„Ki a vállalkozó?” (Who Is an Entrepreneur?)</i>	The competition is intended to give an idea of what young people think about entrepreneurs and entrepreneurial life.
2017	<i>PÉNZ7 – Mondd magyarul! (Money Week – Say It in Hungarian!)</i>	Financial competition for finding a name.
2017	<i>Superhero Comic Drawing and Video Contest</i>	Superheroes were invited to protect the pocket money of students. Participants in the programme were expected to submit comics and videos.
2017	<i>„A Molnár család pénzügyei” (The Finances of the Molnár Family) video competition</i>	Its objective is to strengthen the conscious financial thinking of secondary school students by digitising the teaching materials of the Money Compass.
2016	<i>K&H Színezz, Kész, Pénz! (K&H Colour, Set, Money!)</i>	Drawing competition for creative primary school students.
2016	<i>Financial escape game</i>	Unlike in the case of general escape games, the game developed by the Junior Achievement Hungary Foundation contained only puzzles and codes of a financial nature.
2016	<i>Cetelem Zöldsulni (Cetelem Green School)</i>	Focusing on financial awareness.

6. Other significant programmes aimed at developing financial awareness

6.1. OTP Fáy András Foundation

The activity of the *OTP Fáy András Foundation* stands out among the permanent events organised by other bodies than the banking association. The Foundation provides training for developing young people's financial competences and strengthening their financial awareness. Every year, approximately 30,000 students take part in its free, practice-oriented awareness-raising courses. Its educational programmes have received numerous national and international awards.

6.2. Financial literacy and consumer protection – the guiding role and activity of the MNB

As stipulated in the Central Bank Act, it is the duty of the Magyar Nemzeti Bank to ensure the protection of financial consumers, in particular by way of developing financial literacy, increasing consumer awareness, reducing damages and risks resulting from disadvantageous consumer decisions and facilitating product selection. In order to spread financial knowledge and shape attitudes, the MNB carries out complex activities. It has developed a unified information system, established a national network of consulting offices and closely cooperates with partner institutions and civil organisations. The MNB is the key institution for the development of financial literacy and financial consumer protection (*Hergár – Sz. Pap 2019*).

The task of the Hungarian Money Museum and Visitors Center, established by the MNB and opened on 16 March 2022, is to promote the development of financial awareness among the population and younger generations, and to develop the everyday use of different means of payment. This purpose is served by the Museum's permanent exhibition, complemented by high-quality financial-themed training courses in museum pedagogy offered for groups of school students.¹²

One of the most important flagships in the development of the financial awareness of the adult population is the *MNB's Financial Navigator* programme.¹³ Aimed at transferring practical financial knowledge and consumer protection information in an accessible format, it provides support in a number of typical financial decisions, such as opening a bank account, electronic payment opportunities, savings, borrowing, etc. The complex knowledge base of the programme consists of a website, search and comparison applications that facilitate product selection, a mobile application, a series of information booklets, as well as a number of one-minute or longer educational film clips. A part of the programme content deals with issues related to financial products and services, while another part responds to current events of great interest that shape the market. In addition to using

¹² Money Museum: <https://www.penzmuzeum.hu/muzeum/>

¹³ Financial Navigator: <https://www.mnb.hu/fogyasztovedelem>

various means to inform the public, the programme includes several other types of activities as well, such as communication campaigns related to consumer protection, collaborations or workplace training courses and seminars.

In addition to producing content, the MNB proactively provides information and offers personalised assistance. To this end, in addition to contacting the MNB's customer service by phone, in writing or in person, customers can turn to the MNB's Financial Navigator Advisory Office Network. Established on the basis of effective collaborations with *non-governmental organisations*, the network offers service that is unique in Europe, independent of market players and available free of charge for customers throughout the country. The office network was gradually built up by 2018 and is now available in every county of Hungary.

Money Compass Foundation was established in September 2008 by the Student Loan Centre, the Hungarian Banking Association and the MNB. It was founded with the purpose of developing and implementing financial awareness programmes in cooperation with the authorities, civil organisations and market players. The mission of the organisation is to provide instrumental programmes aimed at supporting the responsible, well-informed financial decision-making of individuals and families, and improving the public's financial awareness. As part of its financial and economic educational activities carried out in the context of public education, the organisation develops textbooks and content, offers advanced studies for teachers in its network of secondary and primary schools, and organises financial educational programmes and playful educational activities. Since 2015, the Foundation has been a permanent co-organiser of PÉNZ7 in Hungary.

In addition to the textbook development activities noted above, the Foundation is also a key player in the continuing education of teachers on financial and economic topics. With all of this, it significantly contributes to the quality and quality assurance of school and extracurricular training aimed at developing financial literacy. Money Compass Foundation regularly measures the effectiveness of programmes aimed at developing financial literacy. The relevant research has clearly demonstrated the effectiveness of advanced studies offered to teachers (*Németh – Deák-Zsótér 2023*). The early findings of the research conducted among secondary school students and 8th graders indicate that extracurricular school activities facilitated as independent subjects or integrated into other subjects (e.g. PÉNZ7 or different competitions), have a positive effect on students' financial knowledge, abilities and attitudes.

7. Moving up in international rankings

As a result of the efforts and commitment, the financial knowledge and literacy of the Hungarian population – which is the basis for responsible financial decisions and the appreciation of financial institutions – is constantly increasing. The OECD

regularly measures the development of the financial literacy in different countries in an international comparison, based on the individual components of knowledge, attitude and behaviour. The research shows that Hungary has made significant progress in the last decade. According to the survey published on 25 June 2020 (OECD 2020), Hungary ranked 9th among European countries and 14th worldwide. Based on the answers to the summary questions of the survey and the “seven financial knowledge questions” of the OECD, Hungary scored slightly lower (12.3) than the OECD average (13.0). In respect of the answers to OECD’s seven questions, Hungary ranks 8th among European countries and 11th out of all the countries examined. Compared to the OECD average, Hungarian respondents performed above average in most questions. Published in 2023, OECD’s latest international comparative analysis clearly indicates that the results of efforts made at improving financial awareness have already yielded results in the country. Hungary achieved an outstanding result in the financial knowledge category, even compared to its previous results, finishing in 4th place out of 39 countries. In addition to the improving results, the targeted efforts to an incentivise a conscious approach to finances must continue in order to achieve similar results in the field of the practical application of knowledge (PÉNZ7.hu 2024).

In recognition of the outstanding participation numbers in Hungary, the Hungarian PÉNZ7 programme was listed among the best of the Global Money Week event series for the third time in 2019. In the same year, PÉNZ7 won the “Pro Bono Initiative of 2019” award of the Voluntary Centre Foundation. In 2021, the European Finance Quiz organised in the context of the European Money Week won first place with a flawless performance by Zsófia Strasszer, a student at Keleti Károly Secondary School of Economics in Budapest. The results confirm the efficiency of accomplished work carried out for the development of financial literacy.

8. Summary and conclusions

Financial education is essential for the public to be able to connect to international financial networks, to manage loans and savings, and to understand the functioning and inherent risks of the financial system. The development of financial literacy is the joint duty of governments, educational institutions, financial actors and civil society. Over the past ten years or so, the development of the financial literacy and knowledge of society in general has become more and more important for the public sector, civil society and economic actors alike, and is regarded as an activity that ultimately leads to an increase in the overall performance of economy.

Financial and economic education was introduced in public education. One of the important milestones in this respect was that the teaching of economic and financial knowledge was listed among the objectives, competences and areas in the National Core Curriculum. At the same time, financial, economic or entrepreneurial skills

are not educated as compulsory subjects outside of technical schools. The Strategy for the Development of Financial Awareness, created in 2016 and then adopted in 2017, was another important milestone in the development of financial literacy. The accredited textbooks and other teaching materials published every year since 2017, which promote the founding and development of students' financial awareness starting from the 3rd grade of primary school until secondary school graduation, are key resources in this respect.

In Hungary, the financial and entrepreneurial theme week, PÉNZ7 (Money Week) is the financial literacy development programme that attracts the most participants. The cooperating professional partners of the programme consider it their mission to shape economic and financial attitudes, as well as to provide assistance with everyday financial situations and conscious adulthood. Taking into account the characteristics of each age group, the special classes of PÉNZ7 convey the knowledge necessary for responsible decision-making in a playful, multifaceted and practical manner. The theme week also serves as an opportunity to bring everyday practice closer to young people by involving financial professionals and entrepreneurs on a voluntary basis.

Research aimed at reviewing non-school financial literacy programmes revealed that the volume of training, the number of training programmes and the number of participants increased almost threefold between 2016 and 2020, meaning that, according to the 2020 figures, the examined programmes involved more than 1.3 million participants. The fact that the duration of the training programmes and the number of multi-day training events organised for adults also increased between 2016 and 2020 is another sign of progress. Students in public education continued to represent the vast majority of those participating in the training programmes in 2020. In addition, the studies also drew attention to the fact that only a small portion of the training programmes were aimed at financially vulnerable adults, and that the income situation and social background of the target groups were given less consideration. In this respect, MNB's Financial Navigator programme is of particular importance, since it is aimed at promoting and developing financial awareness among the adult population, in particular among financially vulnerable social groups, and it is available to adults in need not only by providing knowledge and training, but also by offering advice. In the aforementioned studies, while evaluating the increase in the number of programmes aimed at developing financial literacy and the number of participants, the authors highlight the fact that the quality assurance of training courses has not improved and that measuring effectiveness was not customary. The use of the accredited textbooks and teaching materials issued by the Money Compass Foundation, as well as the wider spread of their culture of measurement, could represent a significant step forward in the quality, purposefulness and effectiveness of Hungarian financial literacy development programmes.

As this article demonstrates, very significant progress has been made in the field of financial literacy and the development of financial awareness over the last ten years. Studies, particularly the findings of the OECD's longitudinal surveys, show that it is now possible to measure the development of financial awareness, especially in terms of financial knowledge and know-how and calculation skills. At the same time, further progress is needed in respect of financial attitudes and behaviour, as well as the practical application of financial knowledge.

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Annex

Regular events of the PÉNZ7

Digitális Szimat Kihívás (Digital Detective Challenge) is an educational game related to the use of bank cards, online payments, password protection, prevention of data theft and digital security, in the form of an online quiz provided by the Hungarian Banking Association and their partners. The purpose of games provided in the context of *Kahoot* (knowledge test and prize game) is to draw attention to the ever-increasing frequency of data thefts.

The *PénzOkos Kupa (Smart Money Cup)* is a national competition in financial knowledge for secondary school students, organised annually within the framework of PÉNZ7. The competition is intended for teams of three, with the assistance of a coaching teacher.

As part of the *PénzFutam (Money Race)* outdoor adventure game, the organisers, i.e. Pénziránytű (Money Compass) in cooperation with PénzOkos Kupa, BankCode in cooperation with Money Museum and Részvényfutam (Stock Race) in cooperation with the Budapest Stock Exchange, offer financial and mathematical puzzles for students in grades 4 to 14. Covering more than 2,000 locations in the country, the team game invites students to solve interesting financial puzzles by going from checkpoint to checkpoint.

Organised by the Money Compass Foundation and the Money Museum, *BankCode* is a four-round national financial team competition for secondary school students.

Részvényfutam (Stock Race) is a free online stock market game provided by the Budapest Stock Exchange (BÉT) and the Money Compass Foundation. Accessible on BÉT's website, the game invites players to test their investment skills by using virtual capital and real shares.

The *Nagy Diák Pénzügyes Teszt (Big Student Finance Test) programme* is organised every year by the Ministry of Economic Development, with the cooperation of supporting partner organisations. The programme covers the topics of savings, investment, insurance and cybersecurity.

ZsetON – Gear up for finances! The Ministry of Finance announced a competition for young people as part of its *Okosan a pénzzel! (Budget Wisely)* programme. Participants are required to provide answers to 16 financial questions in an online test. Since 2023, the competition has been organised by the Ministry of Economic Development under the title 'Nagy Diák Pénzügyes Teszt' (Big Student Finance Test).

FINTELLIGENCE conferences: Since 2017, PÉNZ7 has been organised in higher education as well, dealing with the development of financial literacy and entrepreneurial culture within the framework of the University of Miskolc's Scientific Career Day. The FINTELLIGENCE Financial Literacy Centre was opened at the University of Miskolc in 2018. Since then, additional units have been opened at the University of Pécs, the University of Debrecen and the Budapest University of Economics. The development of financial literacy is facilitated by educational materials and textbooks focusing on particular age groups.

Emerging Market Central Banking and Communication: The Great Catchup*

Piroska Nagy Mohácsi^{id} – Tatiana Evdokimova^{id} – Olga Ponomarenko^{id} – Elina Ribakova^{id}

Emerging market (EM) central banks have made remarkable progress in improving their policy frameworks and communication over the past two decades. Their transparency has improved dramatically; the readability of their statements has been better overall than in advanced economies; their focus on inflation has been sharper; several have proven to be better inflation-forecasters; and they have been more sparing in their use of “forward guidance”, which reduces data-dependence. All this has served them well in the post-Covid period of high inflation. EM central banks have recently outperformed central banks from the advanced economies in two critical respects: addressing and appropriately communicating post-Covid inflationary pressures in a timely manner, and avoiding banking sector stress during the monetary policy tightening cycle. EM central banks also started easing monetary policy from early/mid-2023, ahead of the Federal Reserve and ECB, although reducing inflation sustainably will be the ultimate test of their framework. This study demonstrates these points through the prism of central bank communication, using novel artificial intelligence (AI) methods. We conclude with policy lessons for both EM and advanced country central banks.

Journal of Economic Literature (JEL) codes: B22, C55, E42, E52, E58

Keywords: central banking, monetary policy, emerging markets, Federal Reserve, ECB, communication, forward guidance, AI

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1. Introduction and context

After decades of struggling with high inflation and the underlying failure of various monetary regimes, from the mid-2000s emerging market (EM) central banks increasingly focused on inflation using variants of the “inflation targeting” regime deployed in advanced economies (AEs). Their peculiar circumstances and the global financial crisis (GFC) of 2008–2009 tested the EM central banks’ evolving frameworks and highlighted still-existing vulnerabilities. By the time of the Covid crisis, most EMs were reasonably well-prepared to recognise and address inflationary pressures (Ribakova *et al.* 2020; Nagy Mohácsi 2020). Specifically, compared to their advanced-economy counterparts (Velasco 2022), EM central banks reacted much earlier – starting from the spring of 2021 – to the signs of emerging inflation and their early action appears to have limited the previously often devastating negative impact of the eventual monetary policy tightening in the US and other AEs, as some academics stressed early on. Apart from outliers such as Argentina or Turkey, the emerging markets are currently recording only somewhat higher inflation rates than the advanced economies, in line with their consumption baskets – that have a higher share of energy and food – the two key components of global inflation. In this regard, we would like to stress the importance of a new global policy development from the onset of the pandemic: the wide availability to the emerging markets of currency swaps and repo operations by globally systemic central banks, i.e. the US Federal Reserve (Fed), the European Central Bank (ECB), and, to an extent, the People’s Bank of China. To some limited extent, these tools were already available in the context of the global financial crisis, but during the pandemic the Fed and the ECB (for emerging Europe) made these tools available to most EMs, crucially helping them to maintain their economic stability during the most challenging moments of the Covid crisis and in its aftermath (Choi *et al.* 2022; Vujčić 2020). This has confirmed the indispensable role of currency swaps and repos in the modern global financial safety net.

Even when the Fed and the ECB eventually started tightening in the spring/summer of 2022, capital outflows from EMs and associated exchange rate pressures remained limited, in sharp contrast to past AE tightening cycles. EMs’ early policy tightening with rising interest rates in the context of ample global liquidity may have helped them to meet their foreign capital needs and avoid capital outflows that used to take place in such contexts in the past. Indeed, the IMF has finally recognised that emerging markets have managed the post-pandemic period very well. In the words of the IMF’s chief economist: “Emerging markets have been remarkably resilient in the past 3 years or so” (Gourichas 2024).

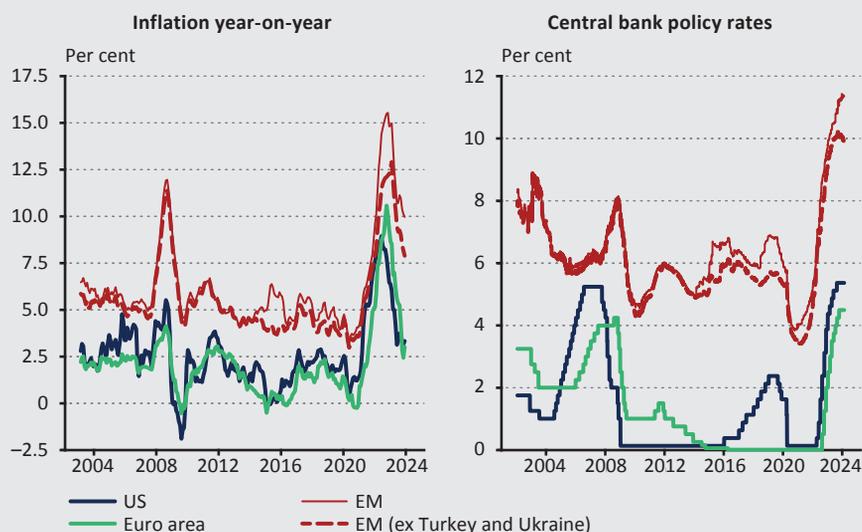
With inflation pressures subsiding, several emerging markets have already started to first signal and then to ease monetary policy, while advanced economy central banks have not yet done so (Figure 1). That said, the ability of EM central banks to reduce inflation in a sustainable manner will be the ultimate test of their improved frameworks.

The aim of our analysis is to assess the record of EM central banks in *communicating* their policy and then *delivering* commensurate policy action over the past two decades.

Communication is now well established as a core element of central bank effectiveness and, ultimately, credibility (see, for example, *Blinder et al. (2008)* for a survey of evidence). Communicating policy intentions and actions in a clear, timely and impactful way strengthens monetary policy transmission mechanisms and improves both central bank effectiveness and credibility.

In this study, we compare the progress of EM central banks to that of the Fed and the ECB. In the process, we gain some insights into the policy and communication record the latter two central banks as well.

Figure 1
Inflation and central bank policy rates in the US, Eurozone, and Emerging Markets



Source: Macrobond, FRED

2. Literature review

Our study builds upon earlier literature that analyses EM central bank communication and how it compares to that by AE central banks.

González and Tadle (2022) present the most comprehensive sample of 18 countries to date, consisting of 6 AEs and 12 EMs. They investigate the use of sentiment analysis in predicting monetary policy changes, relying on custom dictionaries. For a significant majority of the inflation-targeting countries, they find that the sentiment score provides additional information that helps predict monetary policy rate movements. Sentiment across countries tended to co-move during the 2008–2009 crisis. We expand on their methodology (for details, see the appendices in *Evdokimova et al. (2023)*).

The analysis of the length and readability of the statements for five Latin American central banks in an *IMF study (2018)* found that more readable press releases were associated with lower policy forecast error when using the statement tone index.

Armeliu et al. (2020) ran a study on 23, mostly AE, central banks to understand how central banks influence each other's communication across borders, with the Fed's communication being at the centre. They found co-movement in sentiment across central banks, which was partially explained by trade or financial flow exposures.

Laungaram and Wongwachara (2017) focused on the readability of statements of 22 central banks, including EMs. Statements were found to have become longer over time, but the average number of words per sentence was declining. Readability tended to fall when central banks lowered their policy interest rates. Among the six communication topics analysed using Latent Dirichlet Allocation, the net tone of inflation and growth topics were found to be most strongly correlated with the interest rate path.

Tadle (2022) showed a statistically significant strengthening of the US dollar following the publication of hawkish Fed minutes, but no significant response from the stock markets. The analysis also found a positive correlation between minutes sentiment and policy rate, peaking around 12 to 15 months ahead of meeting releases.

In country-specific research, *Carvalho et al. (2013)* decomposed the effect of Brazil's Monetary Policy Committee's (COPOM) statements on the term structure of interest rates. The authors measured the hawkishness or dovishness of the statements using Google search and sentiment analysis, showing that a one standard deviation shift in the hawkish direction increased 4-month to 2-year yields by 2 to 5 basis

points. In a similar vein, *Hansen et al. (2019)* examined the effect of the Bank of England's Inflation Report on the yield curve. *Kawamura et al. (2019)* used Latent Dirichlet Analysis (LDA) to analyse the ambiguity of sentences of the Bank of Japan's communication and found a correlation between obfuscation and negative signals. *Hendry and Madeley (2010)* used latent semantic analysis to check whether Bank of Canada statements affect the returns and volatility of interest rate markets over the 2002–2008 period. *Apel and Grimaldi (2014)* used a custom dictionary as well as LDA to analyse the information content of Riksbank's monetary policy minutes. *Tobback et al. (2017)* constructed an index that measured the tone perceived by the media of the ECB press conferences. *Bohl et al. (2023)* compared the sentiment focus by the Fed and the ECB and found that the mandate of the central bank does affect speech sentiment.

With regards to central bank transparency measurement, we use the well-recognised index by *Dincer et al. (2022)*. Their findings are confirmed and expanded in a recent broader study by *Unsal et al. (2022)*, which considers central bank independence, accountability, policy and operational strategy, and communication (IAPOC). They compile the IAPOC index for 50 countries over the period 2007–2018. For statement readability we use the also well-established Flesch–Kincaid index (originally in *Kincaid et al. 1975*).

Although the body of the literature is becoming vast, to our knowledge only a few papers look into the evolution of EM communication over time as mentioned above, and *only our study focuses on comparing EMs to AEs, covering a long time period as well as the post-Covid inflation shock*.

3. Methodology and data

We assess the evolution of EM central bank communication by using artificial intelligence (AI) tools to analyse the monetary policy statements of 22 EM central banks over the last two decades. These central banks were: Brazil, Chile, Colombia, Czech Republic, Egypt, Hungary, India, Israel, South Korea, Malaysia, Mexico, Nigeria, Pakistan, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey

and Ukraine.¹ The texts of the statements were collected from these central banks' websites.^{2, 3}

The dataset from the statements collected is quite rich and starts before the GFC for most of the countries in the sample, in or around 2003, and thus covers the past two decades. A few countries (Czech Republic, Brazil, Colombia, Mexico, South Africa and Ukraine) have a shorter archive of statements.

We also collected monetary policy statements from the Fed and ECB (since 2002 and 2000, respectively), which we use as comparators for policy communication by EM central banks. In the case of the ECB, we use the introductory statements of the ECB President at press conferences instead of the ECB's statements, because the format and content of the ECB introductory statements is much closer to that of statements issued by other central banks and they provide a more detailed reasoning of the ECB Governing Council's decisions.

On average, we have around 170 statements per country from the roughly 20-year period. Starting from 2003, we have between 5 and 20 monetary policy statements per month for the analysis. We analyse the resulting unique dataset in several dimensions:

- Overall transparency of central banks and the readability of their monetary policy statements,
- Policy “sentiment” and stance,
- “See-say-act” analysis,
- Use of forward guidance in communication,
- Selected central bank topics and specific EM issues,
- Macroprudential focus, and
- References to fiscal policy and the policy mix.

¹ Given the long time period, some of the countries included here have become advanced economies, such as Israel and Korea. We have also conducted our analyses excluding these economies, but the results we present here do not change materially. Most of the countries in the sample (with the exception of Egypt, Nigeria, Pakistan and Malaysia) have an inflation targeting framework, according to the *IMF Annual Report on Exchange Arrangements and Exchange Restrictions (2018)*.

² We collected the published statements in English, and not in the native language of the central banks. One of the key methodological questions in cross-country comparative language studies is whether to use single (typically English) or multi-language text input. The first approach is easier to implement since it does not require setting up language-specific dictionaries or using more advanced multilingual text processing techniques. The caveat though is that translation always carries the risk of not conveying in full the original message, and some central banks include a disclaimer that the native language version prevails in case of a conflict. Similar to the majority of cross-country studies on central bank communication (*González and Tadlé 2020, 2022; Tobback et al. 2017* and others), we decided to use English versions of the monetary policy statements published by the central banks.

³ Further details on the methodology and various sources can be found in the authors' PIIE paper and its annexes (*Evdokimova et al. 2023*).

In addition to the dictionary method used in several studies cited above, we also applied machine learning (ML) methods⁴ to analyse our large data set.

4. Main results

Our main findings are as follows:

1. *EM central banks have adopted many of the principles of advanced economy central banks both in policy conduct and communication, and with appropriate modifications that reflect their different economic circumstances.* Specifically, EM central banks follow, and refer in their communication more often to, areas where they have more vulnerability than AEs. These include capital flow volatility, financial dollarisation and more frequent economic or political shocks, in the context of overall weaker institutional capacity and policy credibility. In such settings, EM central banks pay more attention to exchange rate policy even under inflation targeting regimes as well as to supply side factors that can translate quickly into inflationary pressures amid less-anchored inflation expectations. Moreover, EM central banks are less committed in their “forward guidance” language than AE central banks, in view of their more frequent external and domestic shocks. They also keep an eye on fiscal policy that traditionally carries higher risk of fiscal dominance in their countries.
2. *EM central banks have strongly improved their overall transparency (Figure 2).* Some countries – Chile, Czech Republic, Hungary, South Korea and South Africa – have made major strides (Figure 3) and reached or even surpassed levels seen in the AE comparators.

⁴ These are detailed in our PIIE paper (Evdokimova et al. 2023).

Figure 2
Central bank transparency index: Overall trends, 1998–2019

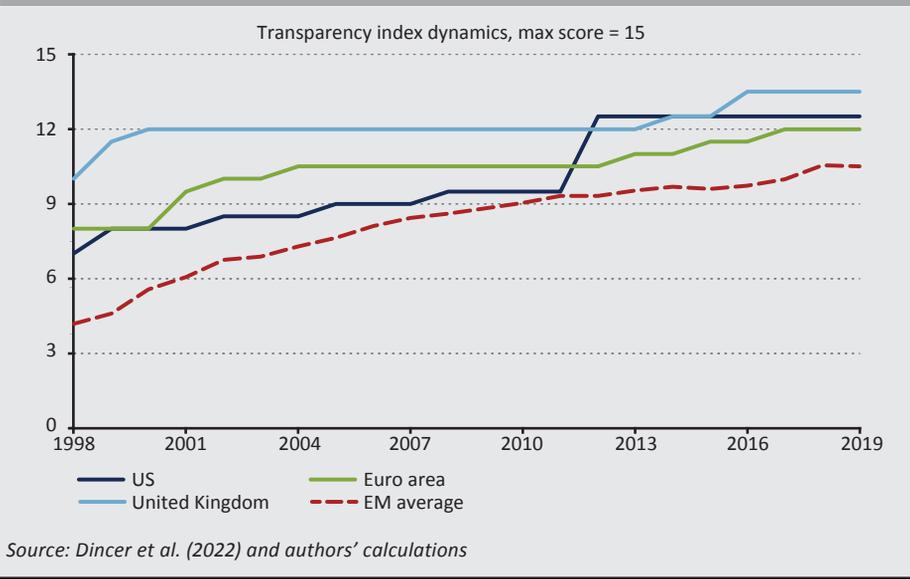
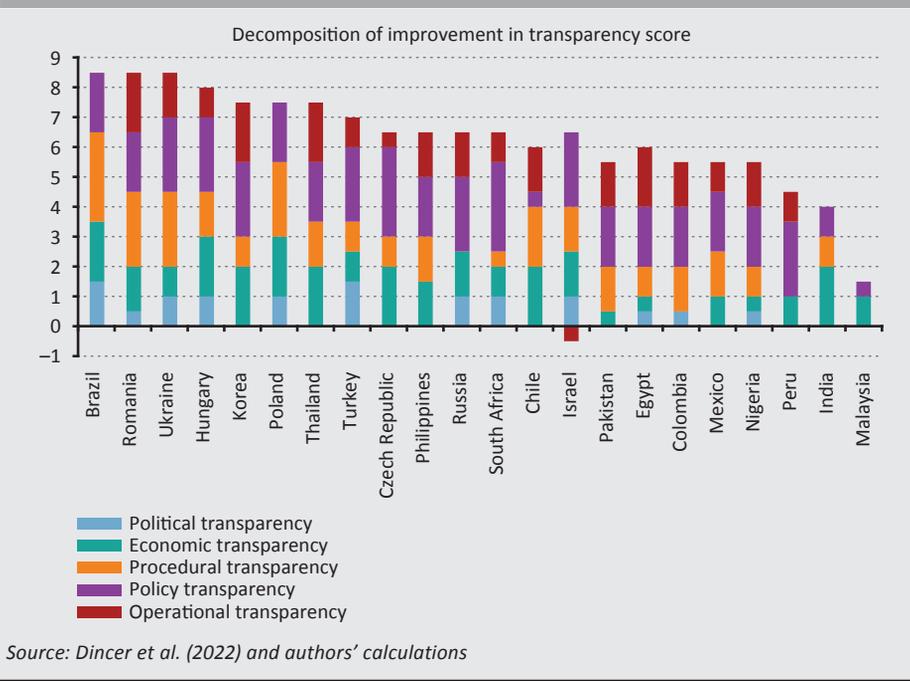
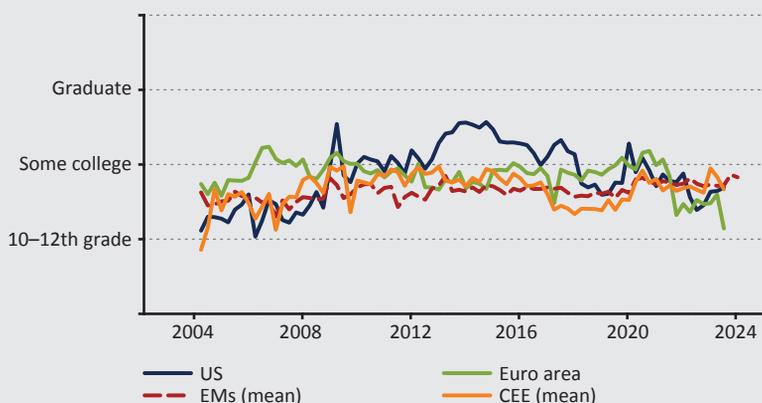


Figure 3
Improvements in the central bank transparency index of countries, 1998–2019



3. The overall readability of central bank statements has been better in EMs than in AEs most of the time, meaning that it requires a lower level of education to achieve comprehension. However, thanks to recent specific efforts of the Fed and the ECB to improve the accessibility of their communication following their respective reviews, the gap between EM and AE communication readability has disappeared. Central Eastern Europe (CEE) stands out as the best EM region for this score (Figure 4).

Figure 4
Readability of central bank statements: Flesch–Kincaid readability index



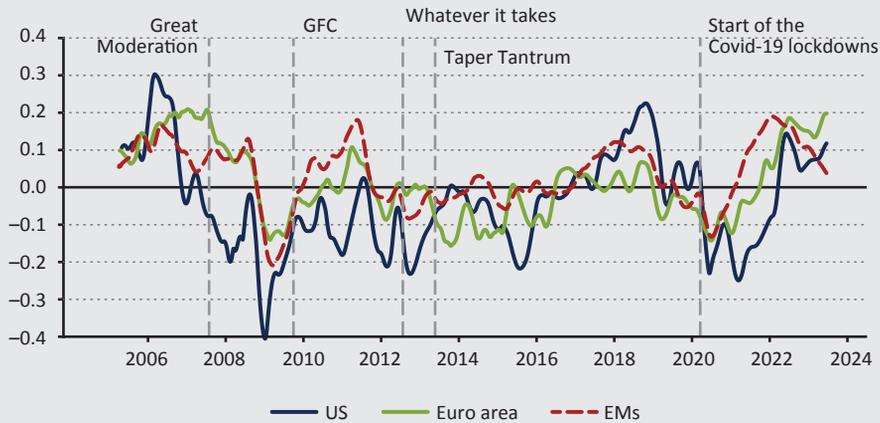
Note: Number of years of education required to understand the text. Higher = poorer readability, lower = better readability.

Source: Kincaid et al. (1975) and its updates and authors' calculations

4. Our sentiment analysis of central bank policy statements reveals how the policy stance and tone of central bank communication have evolved over time. The sentiment analysis assesses how central banks communicate their policy intentions. For that we break down each statement sentence into smaller units where we search for key words. For example, we take the key word “prices”, and then look for modifiers “upward pressure” (on prices) or “downward pressure” (on prices). The former indicates a “hawkish”, i.e., policy tightening sentiment, while the latter a “dovish” i.e., policy loosening sentiment. We assign (+1) value to hawkish statements and (−1) to dovish statements and indicate the average value of such scores in statements. More (+1) values make the statements more hawkish, and vice versa (Figure 5).⁵

⁵ We have developed a dictionary of about 200 words that are featured in economic analysis and thus central bank statements; see our PIIE paper's appendices for further technical details.

Figure 5
Sentiment analysis of central bank statements



Note: Positive value means Policy tightening (“hawkish”), negative value means Policy loosening (“dovish”).

Source: Authors’ calculations

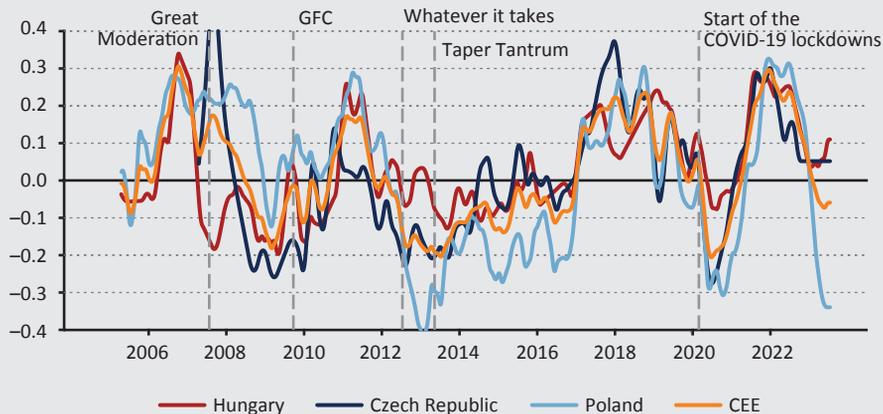
This analysis offers several noteworthy findings:

- Outside of stress/crisis periods,⁶ the tone of central bank statements (hawkish-dovish) is quite similar among AE and EM central banks, mainly driven by Fed policy, in line with the Fed’s leading role in the global financial cycle (Rey 2015, Akinci et al. 2022).
- During crises, AE-EM policy and tone had diverged in the past, but this changed during the Covid crisis. In the past, EM central banks had been left to their own devices and had to react to shocks “alone” (apart from available IMF and other international financial institution (IFI) facilities). During the global financial crisis, initial Fed loosening provided some room for EM central banks to cut policy rates as well, but they soon had to reverse those cuts to defend their exchange rates and fend off inflationary pressures. By contrast, we find that the policy stance during the Covid crisis was credibly synchronised for the first time in economic history, thanks to both EM policy improvements and the wide availability of direct US dollar and euro liquidity support from the Fed and the ECB, respectively (Choi et al. 2022).

⁶ 2008/2009 global financial crisis, the 2011–2014 Eurozone crisis, and the 2020–2021 Covid pandemic.

- Post-pandemic, policy and communication became different again between EMs on the one hand, and the Fed and the ECB on the other hand. While *all* central banks noticed mounting inflationary pressures from the beginning of 2021, EM central banks responded faster and stronger to surging inflation than AEs, and communicated their policy change clearly. Early action in EMs not only helped address inflationary pressures in a timely manner but may have also enabled their financial sector/banks to adjust to the rising interest rate environment earlier and in a more gradual way. In other words, EMs' early monetary tightening may have ushered in smoother adjustments in the financial sector, thus supporting financial stability. No EM countries experienced a banking sector crisis such as the middle-bank crises in the US in the spring of 2023.
- Zeroing in on the CEE among EMs, this is the region that has experienced the highest inflation among mature EMs, in part due to their high exposure to the fallout from the Russia-Ukraine war, and in part to country-specific expansionary (non-defence) fiscal policies such as in Hungary and Poland during the run up of the last elections. The CEE countries moved quickly, albeit cautiously, with policy tightening back in 2021, and Hungary was among the first to signal hawkish/tightening sentiment. The CEE overall sentiment message has recently changed towards "dovish" mode even though inflation is still in the high single-digit range (Figure 6). This however reflected Poland's strong language and policy action of loosening ahead of national elections in October 2023; other countries are appropriately still in "hawkish" territory.

Figure 6
CEE sentiment analysis



Note: Positive value means Policy tightening ("hawkish"), negative value means Policy loosening ("dovish").

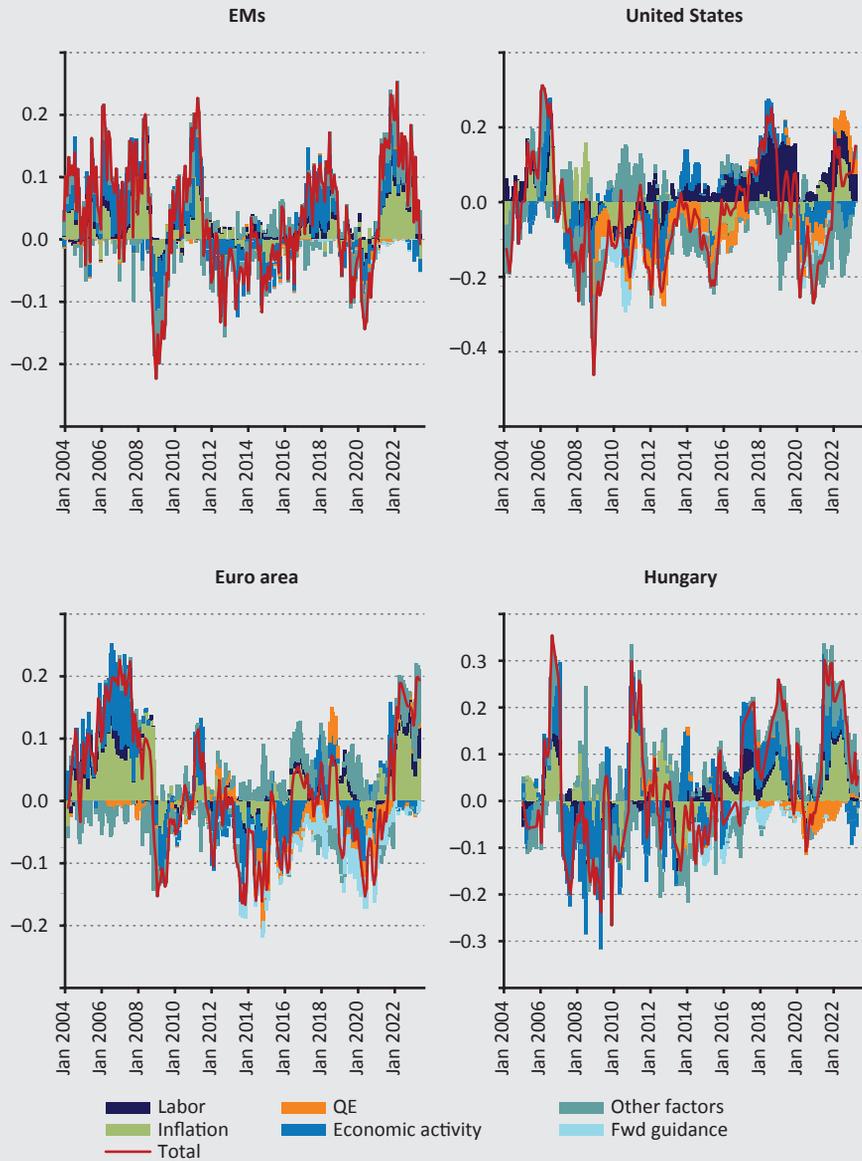
Source: Authors' calculations

5. We use *topic decomposition analysis* to assess central bank focus, breaking the sentiment analysis into several topics (inflation, labour market, economic activity, QE/QT, and so on) within the overall sentiment trend discussed above (*Figure 7*).

In line with their main mandate, all central banks focus on inflation, although the Fed is equally preoccupied with labour market conditions as per its dual mandate. However, we demonstrate in our sentiment analysis that during the post-pandemic inflation shock *EMs were more focused on inflation*, possibly reflecting their historically more recent high-inflation experiences and related policy concerns about less well-anchored inflation expectations. Perversely, they may have also benefitted from the fact that they may not have elaborate models that AE central banks use to analyse inflationary trends or that their confidence in such models is more circumspect. Those elaborate models proved to be of little use or even misleading, because they had been built on data that did not contain inflationary periods. The *Fed* was initially mainly concerned with labour market conditions. Moreover, the Fed's post-Covid communication has occasionally gone "both ways": some parts (such as economic activity and continued QE) signalled dovish sentiment, while others (such inflation) hawkish sentiment from 2021 on, which may have muddled the overall message for a while. The *ECB* did focus on inflation in its communication but still acted with a lag relative to EM central banks to a large degree, with strong reliance on dovish forward guidance.

The topic decomposition analysis for Hungary reveals a few noteworthy points: (i) central bank messaging is quite consistent over time (i.e. mostly hawkish or mostly dovish), in line with other EMs; (ii) the central bank already communicated that inflation was a concern *before* the start of the pandemic; (iii) the central bank used QE extensively during and post-pandemic and communicated this; and (iv) hawkish inflation sentiment was communicated early from 2021 on, though, as in quite a few countries, with some overlap with QE.

Figure 7
Topic decomposition of central bank statements

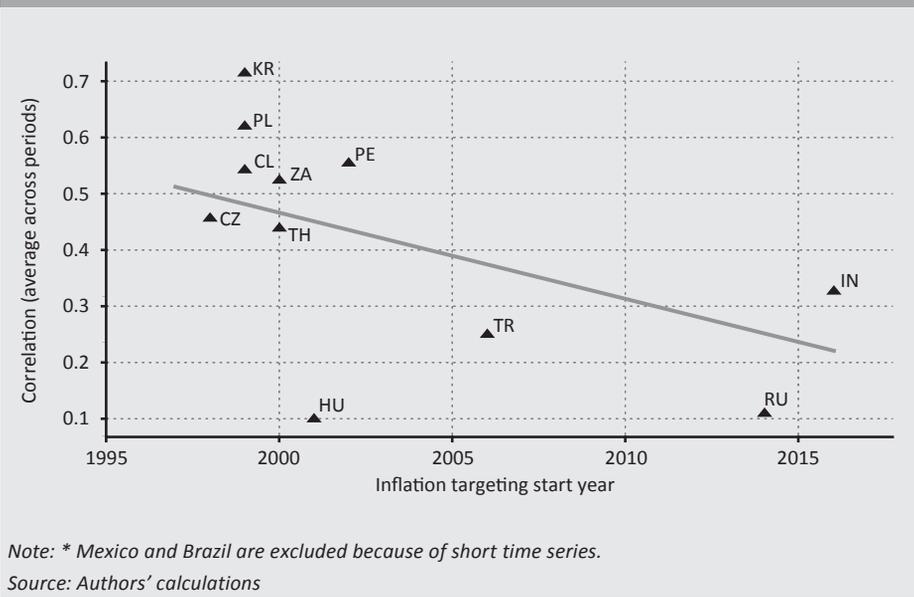


Source: Authors' calculations

6. We assess how well EMs central banks indicate policy change, i.e. how much “heads-up” they give for rate changes. Is the link between that communication and actual policy rate changes strong? Using econometric analysis, we find that EMs give reasonable forewarning and have been particularly successful in indicating policy change during the post-Covid period, but their policy implementation (actual rate change) often remains uncertain. The link between the signal they send and the actual rate change they deliver tends to be weaker than in their AE counterparts: on average, the correlation between signalled policy rate and actual rate change is around 50 per cent, in contrast to the Fed’s and ECB’s 80 per cent or more. This may weaken EM central bank credibility and thus could be an area for improvement for EM central banks.

7. We ask whether the length of inflation targeting experience helps improve the link between communication and policy rate action. We find some evidence that it does: for countries that started inflation targeting earlier, communication correlates more strongly with policy decisions (*Figure 8*).

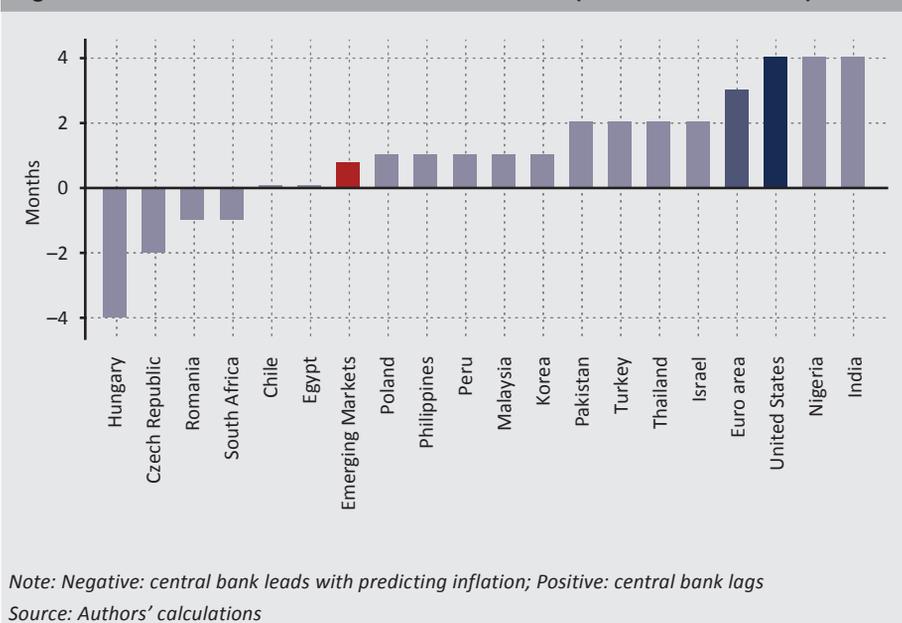
Figure 8
Correlation between tone of monetary policy statements and policy rates versus the time of adopting inflation targeting*



8. We also investigate the *link between central banks communicating their inflation concerns and actual inflation*, which can be seen as a proxy for predicting inflation. We find that, worryingly, central banks in general do not foresee/predict inflation in their communication and only react to the observed inflation with a 2-to-3-month lag. There are some exceptions such as the Czech Republic – which predicts inflation most consistently – as well as Hungary, Romania and South Africa (*Figure 9*).

Figure 9

Lag between inflation sentiment and actual inflation (in number of months)



9. EM central banks understandably focus more on factors that are more specific to their own circumstances. Exchange rate references (even under inflation targeting) are more frequent than in the AE comparators (around 6 per cent of sentences versus close to zero in AE). For the small open economies with a history of financial dollarisation that many EMs are, the exchange rate remains important including for its role in the monetary transmission mechanism and financial stability considerations and thus justifies this focus, even in inflation-targeting countries (*Velasco 2022*). EMs traditionally concentrate more on the supply-side factors of inflation. Macroprudential policy aspects have been increasingly incorporated into EM central bank statements since the GFC, in line with the AE comparators.

10. Finally, despite the importance of the interaction between monetary and fiscal policy in terms of delivering on central bank mandates (the “policy mix”), central banks both in EMs and AEs only refer to fiscal policy trends and never discuss policy coordination.

5. Policy lessons

Central bank policy and communication has undergone a major shift — if not a revolution — over the past two decades. Our paper covers and compares the record of 22 mature EM central banks with those of the Fed and the ECB in this regard. We offer a few policy lessons both for policy and communication, including for advanced economies:

- *Both AE and EM central banks need to improve their inflation projection tools and willingness to recognise price pressures in their communication.* Our analysis finds that, with a few notable exceptions, central banks (AE and EM alike) do not generally foresee/predict inflation in advance. This is a problem, suggesting ample room for improvement on this front.
- *EM central banks need to be better at “walking the talk.”* EM central banks appear to follow up on their signalled policy change less consistently than AE counterparts. While some of this communication-policy action gap may be explained by more frequent shocks in EMs, this can weaken central bank credibility over the longer term.
- *Forward guidance can be detrimental at a time of rapid change.* Forward guidance, introduced in the wake of the global financial crisis in the context of deflationary pressures, was intended to provide additional assurance by central banks on their monetary policy stance (Bernanke 2022). Views on whether it has served its original purpose differ. Here, we would note that it has weakened monetary policy’s data dependence in *de facto* terms, which in turn has proven, in our view, to be detrimental during times of rapid economic change. Until very recently the Fed and the ECB utilised a form of forward guidance despite the gradual easing of inflation pressures since the middle of 2023 (“higher for longer”). Yet forward guidance has proven ill-suited in rapidly changing conditions, and we wonder if its use is advisable during the disinflationary, equally wobbly, path. EM central banks have generally used forward guidance in a less committed and more vague way, which has served them well during times of rapidly changing inflation data and dynamics.
- *Multiple central bank mandates that require multiple policy tools need a particularly clear communication strategy to identify the primary focus during times of stress and potential conflicts among policy goals.* Many central banks

have dual — or even triple or quadruple — mandates. In addition to their price stability goal, financial stability, employment and, more recently, climate change have become part of their mandate. The well-established policy rule of one goal-one instrument underscores the critical importance of a more nuanced, but clear central bank communication strategy in this regard. In addition, during times of stress or rapid change, there can be conflict — at least in the short run — between some of the goals. At such times, central bank communication should explain which goal has priority. In our view, in 2021 and early 2022 the Fed struggled in its communication between its dual mandate on maximum employment and price stability. More broadly, our findings support *Bohl et al. (2023)* that unemployment expectations have driven the tone of Fed speeches since the global financial crisis, while inflation expectations have influenced the sentiment of ECB speeches.

- *Changing the policy goal – inflation target – amid changing economic conditions can be ill-advised.* The debate is on currently whether central banks should change their inflation target. Here we only refer to the experience of the Fed, which changed its inflation objective to “flexible average inflation targeting” (FAIT) precisely when inflation was starting to rise. We wonder if this decision did not inadvertently contribute to its confusing messaging that year. Changing the inflation target, as desirable as it may be, is best done outside of volatile monetary conditions.
- *The distinction between first-round and second-round effects of inflation becomes blurred when inflation rises rapidly.* EM central banks did not waste time and acted fast when inflation started to rise in early 2021. They knew that inflation expectations can quickly de-anchor when prices rise rapidly, blurring the distinction between “first-round” and “second-round” effects. AE central banks need to internalise this policy lesson going forward.
- *It is important to monitor and communicate supply-side factors behind demand-supply imbalances.* AE central banks have typically focused on the macroeconomic (demand) side of inflation pressures, whereas EMs appear to have always had supply side factors on their policy radar screen as well. This served them well in the post-Covid inflationary period. We note that AE central banks have started to internalise this lesson already.
- *EMs have successfully adapted their communication policy to their specific economic circumstances.* Nevertheless, their reduced communication on the exchange rate to conform with the inflation targeting framework might raise questions, given their vulnerability to exchange rate shocks. EMs continue to conduct FX intervention when market stress requires and can increasingly rely on the currency swaps or repo operations that the Fed and the ECB offer. EM central banks could examine if their policy effectiveness would benefit from clearer

communication on exchange rate policy actions. Coordinated communication with the Fed and the ECB during times of currency swaps/repos would help EMs in this regard (though we recognise that this maybe challenging).

- Finally, both AE and EM central banks should reconsider their communication with regards to coordination with their fiscal authorities. The Fed is virtually silent on fiscal policy. The ECB and EMs do better in terms of referencing fiscal policy but are still not fully transparent about any *coordination* of policies. Yet the fiscal and monetary *policy mix* has become part and parcel of modern macroeconomic policy-making everywhere in the world (Allen *et al.* 2021). In this setting, joint review and communication of a country's policy mix would help the transparency, credibility and accountability of both the monetary and fiscal authorities.

Overall, EM central banks have come a long way in their policy and communication, adopting many of the principles of leading AE central banks in both the conduct and the communication of policy over the past two decades. In some important respects, they have recently performed better than their AE counterparts. There is, of course, room for improvement in certain areas that we have highlighted above. Yet in the core area of central banking, fighting inflation and maintaining banking sector stability, EM central banks appear to have come ahead of their AE counterparts, and communicated their divergent views clearly and confidently in the post-Covid period. In these critical areas of central banking, the EM central banks may have overtaken their role models – the advanced country “masters”. With inflationary pressure on the decline, the final test of their improved frameworks will, of course, be if they can bring down inflation sustainably in the period ahead.

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Complementing Money Functions: Central Bank Digital Currencies and Currency Competition*

Jörg J. Dötsch  – Tamás Ginter 

Central bank digital currencies (CBDCs) are currently one of the most vital issues in monetary policy worldwide. While several aspects of the emergence of digital currencies have been addressed in the respective literature, little focus has been directed to one important underlying parameter: the new role of technology in the digital age, which complements the traditional money functions and hence may exert an effect on currency competition. In this paper, we first provide an overview of money functions, currency competition and digital money. We then state that with the emergence of CBDCs, technology has become a new and important functional parameter born by the CBDC itself. We conclude that while technological competition has arisen as a factor of currency competition, stability remains its most decisive factor.

Journal of Economic Literature (JEL) codes: E42, E58, O33

Keywords: CBDC, digitalisation, currency competition

1. Introduction

Interest in digital currencies – be they state-controlled or private – has emerged widely in economic research throughout the past decade. A broad range of studies has addressed, amongst other things, the effect of the emergence of privately-issued digital currencies on monetary policy and financial stability (Bordo – Levin 2017; Nelson 2017), potential technological advancements and the development of new solutions (Auer – Boehme 2020; Maulana et al. 2019), and undesirable implications, such as the use for fraudulent and illegal activities (Gilbert – Loi 2018). Several aspects of the emergence of digital currencies have been addressed in the respective literature. The focus is primarily on the new steering possibilities for central banks in the field of monetary policy. In addition, problems of data protection on the one hand and questions of consumer behaviour, ranging from payment preferences to financial inclusion, on the other hand are discussed.

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It is worth noting that privately-issued digital currencies – “cryptocurrencies” – are actually not *money* in the narrower sense. Nevertheless, it cannot be denied that they raise very specific questions of monetary policy, which is subject to new conditions in the digital age. This is all the more remarkable as the introduction of central bank digital currencies (CBDCs) is currently one of the most vital global issues in monetary policy. However, we believe that an adequate assessment of the role of CBDCs is only possible if one takes into account the increased complexity in the context of currency competition, which is partly due to the existence of digital currencies. This is the subject of our paper.

We proceed as follows. Since this is a fundamental question, we first discuss the most important characteristics of money and its possible forms and then present the role of the money functions. In the second step, we provide a short description of the key characteristics of digital money and tackle the most relevant aspects of recent technological advancements. Then, in the third step, we link the two aforementioned subjects (i.e. money functions and digital currencies) and provide a theoretical framework for the description of the new type of complementation of money functions and what it means in the context of the emergence of central bank digital currencies.

In this perspective of ours, we claim that in conjunction with the development of and emerging competition between (central bank) digital currencies, the list of money functions must be *complemented* with *that of technological competition*. Technology itself does not represent a new money function of its own kind. But digital technology is a new, indispensable factor in the competition among currencies. And within this, focusing on the functionality of money, it is a competitive advantage of a CBDC in its direct competition with cryptocurrencies.¹ While currency competition is a widely discussed phenomenon in the relevant literature (see e.g. *Eichengreen 2005* and *Endres 2009*), technological competition has never before been treated as part of currency competition. Taking this approach, we make a contribution not only to the pertinent body of research, but also offer a perspective to stakeholders interested in the development of (central bank) digital currencies.

¹ While it is debatable (and is debated in this paper, as well) whether cryptocurrencies are currencies at all, we use the term “cryptocurrency” (and not, e.g. crypto asset) not because they are currencies in the stricter sense, but they are most commonly referred to as cryptocurrencies in the relevant literature.

2. Preliminary considerations on the medial character of money

2.1. Money functions and their preconditions

The role of money is commonly described in terms of a minimum of three and sometimes up to six (e.g. *Flynn 2018*) different money functions. For our purposes, we rely on the regularly used, following three functions conceptualised by *Menger (1892)* and *Jevons (1876)* according to which money is

- (1) a *means of exchange*,
- (2) a *measure of value* or *unit of account* (numéraire),
- (3) a *store of value*.

Fiedler et al. (2019:37) point out that money “(...) constitutes a category of its own as it is neither an object of consumption (it does not directly satisfy human need) nor a means of production (the usefulness of money to allow for increasingly complex production process does not depend on its quantity).”

Prima facie, these functions seem self-evident. For traditional currencies, these functions are interrelated and inseparable, so that it would be futile to draw up a sequence with regard to importance. They are always *bundled*. Insofar as we are dealing with a medium of interaction, general acceptance would of course be a fundamental prerequisite for the functions to come into effect at all. Of course, conversely, acceptance necessarily breaks down in the event that only one of the functions does not work properly: this is a gateway for currency competition, as we will show later in a more differentiated way. However, it is neither sensible to isolate the functions from each other in every case nor can they be separated from certain preconditions. A few basic remarks on this.

In order to serve as numéraire, the medium must be *divisible*. To be able to be used everywhere it must be *transportable*, in whatever form. To be able to be used anytime and to serve as a store of value it must be *durable*. And, at least, it must be *free of manipulation* so that the partners in a transaction are not exposed to risks for the benefit of third parties. Money must be scarce *per se*, otherwise it couldn't be a measure of scarcity over time. Since *all* of these preconditions are always important for the functioning of the medium of money, they can be summarised under the postulate of a *stable money value*.²

² There is a wealth of academic discussion surrounding the demand for a stable monetary value, which cannot be fully reproduced here. It is important to note that the monetary functions mentioned cannot operate as intended if the value of money is not stable. *Friedrich August von Hayek (1999:239)* most notably addressed this issue from the perspective of private currency competition: “(...) a private institution which must issue money in competition with others can only remain in business if it provides the people with a stable money which it can trust. The slightest suspicion that the issuer was abusing his position when issuing money would lead to a depreciation of its value and would at once drive him out of business.” With regard to public issuers, the same principle applies; they must earn their credibility over time. Considering the institutional context and the role of central banks, *Friedman (2002:38)* further emphasises that it is their responsibility to “(...) provide a stable monetary framework for a free economy”.

These preconditions are important always and everywhere and it is no coincidence that have they been discussed for almost as long as money exists (see e.g. *Crespo 2021:459*). This discussion “(...) is part of a long historical interaction between technology and society” (*Söderberg 2018:2*). If we consider digital technology as a “general purpose technology” (*Bresnahan – Trajtenberg 1995*), this discussion is indeed very urgent today. As we will see, this is about more than the just fact that money today no longer needs to be coined to be durable: The requirements for it have become more abstract and complex. This leads us to the important aspects of the technology and architecture of monetary systems.

2.2. Technology and architecture of monetary systems

Monetary systems are institutional solutions of how money is created and its value is protected. Both tasks are interconnected. *Fiedler et al. (2019:11)* expediently distinguish two basic components of monetary systems: their *technology* and their *architecture*. In simplified terms, the architecture refers to which institutions can issue which kind of money under which conditions and in what form it comes into circulation. The technology refers to the aspect of the practical realisation, how a medium is created or declared to serve as money. According to this, traditionally there are three basic types.

- (1) Media used as money can have a value as a commodity and work as “commodity money”. Obviously, this can be precious metal,³ but depending on the economic situation, it could also be anything else (see, classically, *Folz 1970:40*). The individual actors in the economy can thus decide whether they derive utility from the *function* of a medium as money or from its *material value* (*Köhler 2019:24*).
- (2) Money can be created as a *declared equivalent* for a good or service. Accordingly, money can be created by a central bank, which, for example, ties the money to an underlying good with a stable market value, e.g. precious metal. If it sells the corresponding precious metal, the money is accordingly withdrawn from the economic cycle again (see *Köhler 2019:24*). Since money was usually linked to precious metals in this way of money creation, it is also referred to as *metallism* (see e.g. *Cesarano 2014*).
- (3) Money can be created by *granting credit*. Here, the creation of money is not preceded by a barter transaction as in the second system. Such a currency, in which the medium in the narrower sense has almost no material value anymore,

³ The fact that gold is the most common form of “commodity money” should not lead to the misconception that gold is so particularly suitable for the production of physical money because it is also so highly valued as a commodity in other forms. In addition to the technological requirements in the narrower sense, the actual cause is rather functional, namely that although gold is available in sufficient quantities, it is one thing above all: scarce.

is accordingly the antithesis of the first system, while the second system occupies an intermediate position. The medium of this system is fiat money.

Ultimately, money functions based on the trust that users can receive real value or service in exchange. Money serves as both a claim and a promise in all transactions, but ultimately, these claims and promises are resolved through the central bank, which controls the supply of money.

In developed economies, the third system is usual. It is based on the *economic* argument that it is the most elastic with regard to the dynamics of the economy.⁴ On the other hand, there is a *political* and consistently unspoken argument: people in charge are used to being interested in increasing the money supply for political purposes, and this is easiest with fiat money. Expansion of the money supply carries the risk of inflation.⁵ In this context, therefore, very important balancing problems arise that cannot be discussed in this framework. This problem is not only as old as money, it stays with all kinds of money as long as there is no answer to Juvenal: “*Quis custodiet ipsos custodes?*”⁶ But this is, again, not our topic.

However, fiat money is only accessible in two forms: either in the form of cash, i.e. token-based, or in the form of reserves. As far as *access* to money is concerned, the architecture of our recent monetary system is two-tiered. The reserves are only accessible to commercial banks. Commercial banks therefore play, in a sense, a role as an intermediary that can provide accounts to non-banks, i.e. citizens and businesses. Non-banks accordingly have claims on commercial banks in the form of these accounts denominated in a currency. Here, the money is correspondingly account-based, i.e. the money can be clearly assigned to an owner by a third party – the intermediary, a commercial bank (see *Brunnermeier et al. 2019:5*). For the purposes of our contribution, we do not separately treat central bank money in the form of cash on the one hand and the money available in the accounts of commercial banks on the other. In view of the functionality of money focused on here, this would not make much sense. However, it should be noted that central banks that are publicly considering the introduction of CBDCs do emphasise its quality as central bank money.

⁴ It is important to note that the flexibility provided to politics by a fiat money system, which allows for the cushioning of short-term economic problems through monetary means, can lead to an “inflationary bias”. This bias has always resulted in inflation, which ultimately leads to the destabilisation and destruction of the money’s functions, ever since the existence of fiat currencies. See *Bernholz (2015:18)*.

⁵ This statement is contradicted by modern monetary theorists, see e.g. *Mitchell et al. (2016)*. However, we do not address the questions related to MMT in this paper.

⁶ In English: “Who guards the guardians?”. Basically, one of the crucial questions for institutional economics. See for example *Hurwicz (2008)*.

3. Digital currencies

3.1. Context

Why is it necessary to create ‘digital money’ at all? Aren’t the existing currencies and monetary systems already sufficient? Numerous aspects play a role here. One is the demonstrably gradually diminishing role of cash in transactions in modern economies (*Harasim 2016*). Apparently, more and more payments are being made electronically, i.e. also digitally. In this context, many publications mention a transition to a “cashless society” as a background (e.g. *Fiedler et al. 2019:9*). In the discourse of monetary theory, one also speaks of “trends of dematerialisation and informatisation of money” (*Nishibe 2020:314*).

There are very different causes for this. For example, the successively lower significance of cash may have *cultural* causes such as the willingness to accept innovations, which we assume to be more pronounced e.g. in China than in Europe. The possibility to reduce transaction costs in the sense of time and fees is an economic argument.⁷ Indirect network externalities with regard to the spread of digital currencies may play a role on certain social platforms that use their own currency as a form of community money (see e.g. *Brühl 2020*). In addition, digital currencies may serve as a store of value instead of a central bank currency. They are hence used as an asset, a “crypto-asset”, which is “(...) a digital representation of value or rights which may be transferred and stored electronically, using distributed ledger technology or similar technology” (*European Commission 2020:34*; see e.g. *Khan – Hakami 2021:22*). Of course, this kind of use is partly speculative (see e.g. *Khan – Hakami 2021:22*).

These phenomena are basically nothing new and, as *Fiedler et al. (2019:11)* point out, electronic payments, transfers, etc. have hardly affected the architecture of the monetary system so far. However, the volume speculated within the form of crypto-assets should also not obscure the fact that cryptocurrencies call themselves currencies, but cannot fulfil the functions briefly outlined above like central bank money. Or can they? The next section focusses on the differences between crypto- and traditional currencies.

3.2. Differences compared to central bank money

It should be noted that there is no uniform definition for the phenomenon of digital currencies (*Söderberg 2018:1*). This somewhat loose term encompasses various forms and it is to be expected that other forms will appear (*IMF 2021:5*). The European Central Bank (ECB) defines the term “cryptocurrency” as “(...)

⁷ Referring to his research on Bitcoin, *Stroukal (2018:41)* emphasises that the immediate transaction costs are indeed low, but he also considers “hidden costs”, concretely “direct transaction fees, bounties paid to miners, and increased risk”.

a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community” (ECB 2012). This is also followed by Söderberg (2018:1), who speaks of “(...) digital units that are created and transferred between the users through the use of cryptography”.⁸ There are now more than 10,000 of these unregulated phenomena on the market,⁹ and the variety of variants is remarkable. There are eMoney, stablecoins, crypto-assets, tokenised bank deposits, tokenised financial assets and others, and thus it is a “rich landscape” (Halaburda et al. 2022:107) of different forms not all of which are covered by the definition of crypto-assets. For the purposes of our considerations, we will leave it at this: there is a wealth of media in the digital sphere that can at least partially fulfil monetary functions and which – sometimes more, sometimes less justifiably – are generally referred to as “digital currencies”.

Regarding the *technological* side of the monetary systems, so far central bank money is only available to citizens as cash; undertakings and citizens hold their accounts at commercial banks, which are supplied with central bank money by the central bank. Citizens and businesses can carry out transactions only through the network of these private intermediaries. For our question, which is orientated towards functional aspects of money, it is initially not analytically necessary to distinguish between the central bank money available to citizens in the narrower sense – i.e. cash – and the claims on the accounts of financial intermediaries. The latter are also denominated in the units of a corresponding central bank currency. It is due to the architecture of the monetary system that a distinction can be made between ‘real’ central bank money and claims expressed in central bank money units. We will return to this later.

With regard to the architecture of the monetary system, the background of cryptocurrencies is correspondingly different, as the level of commercial banks is eliminated and transfers among the participants of a community are possible directly as a peer-to-peer procedure. This is generally faster and also cheaper (IMF 2021:5). This means that cryptocurrencies also move outside of the usually nationally determined currency areas and are in principle global: instead of a local community, they are a “virtual community of interest” (Nishibe 2020:315). Cryptocurrencies “(...) can be distributed much more widely, including across devices and borders” (IMF 2021:6). They can be monetised, but they only exist digitally and are not realised physically.

⁸ The technical side of the cryptographic process in the narrower sense is not our topic. Most crypto-assets are based on the blockchain, but not all are (such as Iota). In the context being considered here, the technology itself – distributed ledger technology – is essentially unimportant because, in theory, any medium that satisfies certain functional characteristics can be classified as money.

⁹ It is important to bear in mind that this number has grown with astonishing dynamism so far. Söderberg (2018) still mentioned about only 1,500.

The technological background is provided by decentralised networks. The founder of bitcoin, known under the pseudonym Satoshi Nakamoto, is often quoted as saying that cryptocurrencies are “(...) a new electronic cash system that uses a peer-to-peer network to prevent double-spending (...)” that is “(...) completely decentralised with no server or central authority” (quoted after Luther – Smith 2020:433).

Cryptocurrencies are not legal tender and therefore lack an important stabiliser mechanism for acceptance. Media that are declared a public means of payment thus have a critical mass *per se*, in which corresponding network externalities unfold.¹⁰ Cryptocurrencies may appear in connection with existing communities, but the use there is then already restricted by the scope of this community, and possibly also within it. Brunnermeier *et al.* (2019:19) accordingly mention “digital currency areas”, which only exist within a corresponding, non-state network. The respective cryptocurrencies thus gain their stability exclusively from the quality of this network: First of all, exclusively through acceptance as a medium of exchange by a critical mass of participants *for whom the volatility risk plays a relatively minor role* in relation to central bank currencies. They are decoupled from state power and they are also decoupled from the economic performance of a currency area. These communities thus work differently from traditional currency areas in the sense of Mundell (1961). It can therefore be said that they are generally more volatile than central bank currencies. The less they are backed by real values or pegged to central bank currencies, and the more volatile they are, the more they have a “(...) *dynamic instability problem: it may suddenly lose its transaction value if people believe that in the future, others will not accept it in exchange*” (Brunnermeier *et al.* 2019:24).

While central banks can in principle create fiat money in unlimited quantities,¹¹ the possible quantity of cryptocurrencies produced through so-called “mining” can be technically limited due to the very mathematical procedure, the encryption technology, which defines them and precludes counterfeiting at the same time. This endogenous, ‘technical scarcity’ is a remarkable parallel to metallism in money creation (see Sanderson 2015; Cesarano 2014). Söderberg (2018:2) therefore speaks of “digital metallism” with reference to Maurer *et al.* (2013).

With regard to any cashless operation, the security of money in a central bank currency system – e.g. securing ownership of accounts, clearing procedures, banking secrecy, etc. – is left to the intermediaries, while the counterfeit-proofing of cash and the stability of the currency itself is provided by the promise of a central bank.¹²

¹⁰ This stability is internalised by cryptocurrencies that are backed by (possibly several) central bank currencies. They absorb their stability and are called, very obviously, stablecoins.

¹¹ This is a technical possibility, but there are practical limits to it. The practical limit can only be denied on the assumption that there is no connection between the money supply and the value of money (see footnote 5).

¹² Of course, the relevant intermediaries are not completely left to their own devices. In developed economies, they are *de facto* subject to corresponding bodies of public control, and misconduct would also be penalised by the market, at least as long as there is relevant competition.

A cryptocurrency offers greater security against access by third parties, including the state itself: private “wallets”, in which the quantities of units of the respective cryptocurrency, each with defined property rights, are stored instead of accounts in commercial banks.¹³

Not least because of these aforementioned functional differences compared to central bank money, there is also a significant difference in terms of the performance of crypto-assets. Their value relative to central bank currencies generally fluctuates considerably. The aspect of relative performance draws the attention to competition. The following section is dedicated to this.

3.3. Cryptocurrencies and currency competition

Currency competition is a widely studied field. Without being able to go into this in depth here (for an overview, see e.g. *Cohen 2015*, also *Karau 2022*; *Mayer – Bofinger 2023*), we focus on the complementation of functionality in this context. Just a few remarks to clarify the background must suffice.

Competitive relationships between currencies can develop due to the fact that currencies represent complex solutions to problems (see e.g. *Gerba – Rubio 2019*). Each individual monetary function can be understood as a partial solution. Hence, we assume that for example for the store of value function, a currency will be favoured that is relatively more likely to fulfil this function (see below). In principle, currencies fulfil all three functions, which are interdependent, as long as they are *stable*. In addition to the fact that the means of exchange used within a currency area is prescribed in principle, the stability of a currency is, of course, influenced by a large number of factors that go beyond its sheer functionality. For example, the size and performance of the respective economic area or trading habits, however justified and enforced.

However, competition always arises for currencies as soon as money owners decide in which currency they want to hold their money. Whenever it comes to “holding”, the function of the “store of value” becomes dominant and the respective owners will ask themselves which medium serves this goal best. This *can* be a (central bank) currency – which is why one or more foreign currencies are usually a component of the portfolio in asset management – but it does not have to be. However, currently, crypto-assets come into focus with this problem.

¹³ At first glance, such wallets appear to be more secure against access by third parties. This may be true for many users, but there are also counterexamples. In March 2023, for example, the US government confiscated bitcoins (see *Redman 2023*). These wallets are therefore not completely “watertight”. However, if the argument put forward by most central banks and numerous experts in this discussion that many criminal activities are carried out with cryptocurrencies is to be taken seriously, the possibilities of state observation and intervention will have to be assessed as relatively limited.

The fact that crypto-assets known in everyday language as “cryptocurrencies” are not actually money in the stricter sense does not mean that this new phenomenon does not influence currency competition under the conditions of digitalisation. According to *Brunnermeier et al. (2019)*, digitalisation leads to a differentiation of monetary competition with regard to different monetary functions.

How this differentiation unfolds can be explained with reference to Gresham’s Law: If two different types of money are in circulation – in the classic case silver coins and gold coins – which have the same denomination and can be exchanged one-to-one, the currency that is considered to be a poorer store of value will stay in circulation as medium of exchange, while the other, which is considered to be a better store of value, is then hoarded accordingly (see e.g. *Horváth 2022:543*). Accordingly, because one type of money is not competitive in the long term with regard to one certain money function, a crowding-out effect occurs.

While the crowding-out effect in the example with cash unfolds due to a preference with regard to the expected relatively better fulfilment of the *store of value* function, the situation becomes much more complex under digital conditions. This is because, in principle, relative preferences for certain functions can come into play wherever exchange is not carried out using cash. Digital money *or* central bank money may be preferred *for certain functions* and, hence digital currencies “(...) *could threaten individual countries’ monetary sovereignty by displacing domestic currencies*” (*Auer et al. 2021:9*).

Specifically, what functions might these be? If, as established above, on the one hand, there are necessary preconditions for any medium to serve as money (see *section 2.1*) and, on the other hand, private digital currencies can neither be enforced by the state nor is their value linked to the economic performance of a currency area,¹⁴ then, from a functional perspective, we assume three drivers for a preferential use to remain (for similar arguments, see e.g. *Mayer – Bofinger 2023*):

- (1) The scope of indirect network effects as a (self-enforcing) prerequisite for general acceptance. These are a crucial prerequisite for anything to be able to function as a *medium of exchange* at all.
- (2) The relative weight of the assumption/expectation that a medium is relatively better suited as a *store of value*.
- (3) Technical possibilities that digitalisation offers – beyond the previous possibilities of cashless payment and savings.

¹⁴ As mentioned above, stablecoins occupy an intermediate position in this respect. For the purposes of our considerations, we make no further distinctions in this regard.

Following the example of Gresham's Law, a crypto-asset could potentially be considered as an alternative to inflationary central bank currencies.¹⁵ Even in this perspective, if only means of payment denominated in central bank currencies are *money* in the stricter sense, a competitive relationship still unfolds. It is not exactly the same situation as a competitive relationship between (a minimum of two) central bank currencies, one of which is relatively more stable and the other relatively more inflationary. Nevertheless, the effect on the relatively weaker medium is the same. And as long as certain crypto-assets are also used as a medium of exchange within certain communities and can be converted into central bank money if necessary, the process described here is also more similar to currency competition than other forms of asset inflation.

Of course, crypto-assets and central bank currencies start from a very different basis. The unfolding of indirect network effects is partly inhibited by the sheer fact of public issuance. Although cryptocurrencies are global *per se*, they are fragmented by different spaces of public regulation and other technical obstacles. In this respect, a complex regulatory problem arises with regard to the important question of convertibility, which sets corresponding limits to the success of cryptocurrencies in one or the other functional area. Other barriers that are relevant for traditional currencies, such as exchange costs, are eroded by the possibilities of digital technology, at least as long as we are talking about use in the digital realm, i.e. non-cash. Exchange costs would be in principle lower, because the exchange of digital currencies not only takes place without time expenditure, but also lacks a third party to whom fees might have to be paid (see Brunnermeier *et al.* 2019:11).

With regard to the *store of value* function, there is thus a potential effect of the existence of cryptocurrencies that is not dissimilar to international currency competition. The volume of claims expressed in cryptocurrency measured in units of a central bank currency alone should make this clear.¹⁶ At first glance, however, other functions seem to remain unaffected, such as the fact that a cryptocurrency would in some way be better suited as a medium of exchange than "real" central bank money, i.e. cash, or – for the sake of completeness – claims expressed in central bank money units at the corresponding intermediaries. However, the aforementioned effects and the potential of digital technology seem to be given such weight by central banks that they have invested heavily in considerations for the creation of central bank digital currencies.

¹⁵ In this case, this means that the less secure it is considered to be in the long term to hold values in a central bank currency because it is inflating or there is a corresponding *expectation* of inflation, the more likely it is that the central bank money will no longer be used as a store of value but will be invested in corresponding assets; the relatively less valuable medium will then continue to circulate. This logic is just as inherent to money as the phenomenon of asset inflation mentioned here is an empirical commonplace.

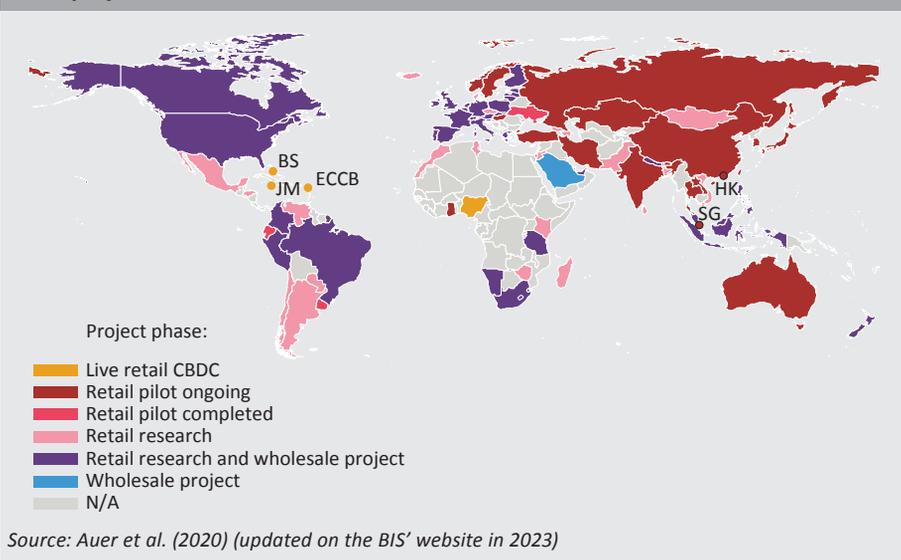
¹⁶ Of course, it is another matter whether crypto-assets will fulfil their function as a store of value, not least because they are undoubtedly more volatile in the short term compared to central bank money. As Brunnermeier *et al.* (2019, 24) put it, they have a "dynamic instability problem", which they attribute in particular to the problem of acceptance. Accordingly, it would not be inaccurate to categorise them as an object of speculation. However, it is not possible to make a clear distinction, because not only can central bank money also be used for speculation but depending on the term, any storage of value has a speculative character. See also the previous footnote.

4. Central bank digital currencies

4.1. Preliminary considerations

Regarding the architecture of the monetary system, CBDCs would enable private households or businesses to gain *direct* access to a central bank account – similar to what was previously the case only for commercial banks. “CBDCs can be defined as a form of digital money, denominated in the national unit of account, which is a direct liability of the central bank” (Auer et al. 2021:3, referring to Group of central banks 2020). It would be “(...) an electronic form of central bank money that can be exchanged in a decentralised manner known as peer-to-peer, meaning that transactions occur directly between the payer and the payee without the need for a central intermediary” (Bech – Garratt 2017:56).¹⁷ The European Central Bank describes its idea of a digital euro as “(...) an electronic equivalent to cash. And it would complement banknotes and coins, giving people an additional choice about how to pay” (ECB 2023).¹⁸ There has been quite an intense debate on this for almost half a decade (see Auer et al. 2021; Agur et al. 2022; Panetta 2021a, 2021b, 2021c) and according to Boar – Wehrli (2021) by 2020, 86 per cent of central banks had already conducted research in CBDCs and more than 50 central banks had already published their results by that time.

Figure 1
CBDC projects around the world



¹⁷ Bech and Garratt (2017) use the term “central bank cryptocurrencies” because of the underlying technology, but this makes no difference.

¹⁸ In principle, this idea is actually not new; Auer et al. (2021:4) also refer to the proposal by Tobin (1987).

This allows for variations which affect both the technology and architecture of the monetary system. CBDCs could be token-based or account-based, and there are conceptions for *wholesale* or *retail* variations. The technological basis could be distributed ledger technology or the existing technological infrastructure (see Auer et al. 2021:3). However, the perhaps most important aspect regarding the architecture of the monetary system is that the role of commercial banks would then only be optional.¹⁹ This constellation would induce commercial banks “(...) to make their deposits more attractive and increases the costs of funds for commercial banks” (Auer et al. 2021:15).²⁰ By adding a new form to the existing forms of central bank money the central bank’s reserves would be merged with CBDC, “(...) (b)ase money is extended beyond cash and reserves to a third aggregate state – unless reserves are simply merged with CBDC units by granting unrestricted access to reserve accounts” (Fiedler et al. 2019:17).

What would be the essential difference compared to the aforementioned crypto-assets? What advantages would a CBDC offer? The motives seem to be different or are stressed differently in different jurisdictions (Auer et al. 2021:7). The main difference would of course be the issuer itself. A unit of a CBDC would be a claim against a central bank, ‘backed’ by the state or states forming the respective currency area. It would accordingly be denominated in the respective national currency and could serve as a numéraire. It would be a legal tender that, unlike private cryptocurrencies, can be used everywhere for payment. *Prima facie*, therefore, there would – apart from the change in the architecture of the monetary system – be no difference at all to the previous central bank money *in terms of the functions* that money must be able to fulfil. It would be only the technology that makes a difference. So what is the point?

4.2. Motives

Central banks emphasise the advantages of CBDCs: on the operational side, faster payment processes, and even goals such as “financial inclusion” (ECB 2022). The European Central Bank hopes that a digital euro “(...) could foster financial innovation and improve the overall efficiency of the payments system” (ibid.).

On the one hand, it is an open question whether these aspects are a problem at all. On the other hand, arguments are also put forward, such as the need for central banking technology to keep pace with changes in the modes of payment because “(...) retail payments are (...) undergoing a disruptive transformation” (ibid.). The ECB thus alludes to point (3) of preferential use mentioned in the previous chapter.

¹⁹ In fact, most central bank projects currently leave the commercial banks in their role. However, even just the technological potential for a shift in the architecture of the monetary system of this magnitude is a new dimension.

²⁰ This summarised with reference to Andolfatto (2021), Keister – Sanches (2021) and Chiu – Koepl (2019).

The central bank would like to respond “to the increasing demand for safe and trusted electronic payments” (ECB 2022).

The ECB thus attests a problem of trust with regard to the existing technical payment solutions. And although the demand for “trusted payments” is already increasing, the ECB fears that the only central bank money available for non-banks, cash, “(...) could (in a digital world) become marginalised as a means of payment” (ibid.). Correspondingly, it envisages the digital euro as an “(...) anchor of stability for the payment and monetary systems” (ibid.). This metaphor is probably intended to address points (1) and also (2) mentioned in section 3.3.

At the same time, a digital euro “(...) would also strengthen the monetary sovereignty of the Euro area and foster competition and efficiency in the European payment sector” (ibid.). The first part of the sentence is probably most closely related to point (1) mentioned in section 3.3, but only makes sense if we assume that there is competition with other media of payment. If this were not the case, then the ECB would be talking about its own sovereignty as an institution. This also confirms its statement that a digital euro “(...) would preserve the role of central bank money as a stabilising force of the payments system” (ibid. p.2). The argument behind the assumption that a digital euro would foster competition in the European payment does not need concern us here.

Chen et al. (2022, see below) provide an international and empirically backed overview of the numerous motives. Reviewing the relevant Hungarian literature, a fivefold categorisation of the motives for introducing CBDCs unfolds.

First, the introduction of central bank digital currencies is viewed as an enhancement of monetary sovereignty (*Fáykiss – Szombati 2021; Horváth 2022*), or, in other words, the strategic autonomy of a currency area (*Terták – Kovács 2022*). The emergence of cryptocurrencies and numerous FinTech and BigTech companies (typically resident in the United States) allowed the US dollar to gain power in such transactions (see *Fáykiss et al. 2021*), and thus CBDCs are supposed to prevent the dollarisation of the respective national (or in the case of the euro, supranational) currencies (see also *Kóczyán 2022*).

Second, another international aspect of the introduction of CBDC would be the increased efficiency of international payments by enhanced interoperability, providing gains for both companies and individuals transacting across borders (see *Boros – Horváth 2022; Müller – Kerényi 2022; Terták – Kovács 2022*).

Third, the introduction of CBDC would provide more and new scope for monetary policy (*Fáykiss – Szombati 2021*) and could potentially increase the efficiency of monetary policy (*Müller – Kerényi 2022*), allowing for direct monetary transmission in case of interest-bearing CBDCs (*Kóczyán 2022*; see more on that in section 4.4).

Fourth, literature suggests efficiency gains in the banking sector, as CBDC introduction is supposed to enhance competition among financial institutions (Kóczyán 2022; Kóczyán et al. 2022). This enhanced competition is nevertheless a significant risk for commercial banks' business models, and also elevates the long-term risk of bank runs (Müller – Kerényi 2022).

Fifth, fellow authors suggest that CBDC innovations should become 'sticky' by boosting financial and technological innovations in the private sector (Kóczyán 2022; Kóczyán et al. 2022; Müller – Kerényi 2022).

In their paper, Fiedler et al. (2019:9) have assembled the above arguments to some extent as "(...) higher revenue, efficiency of the payment system, traceability of illegal transactions, surveillance, upholding the public monopoly of money, countering competition" (Fiedler et al 2019:9).

With regard to currency competition to be countered, it is then only the "efficiency of the payment system" which goes beyond the actual parameters of currency competition in the traditional sense. However, competition no longer takes place in the same way as in pre-digital times. Would the efficiency – to leave the critical aspect of network effects for these considerations aside for now – that would be achieved through technology increase the competitiveness of the CBDC and hence of the respective currency?

4.3. Currency competition through functional complementation

The emergence of (central bank) digital currencies thus provides an incentive to reconsider the set of functions money can have as described above. The categorisation, for example by Flynn (2018), provides a set of functions that is attributed to money itself (let it take the form of coins, banknotes, bits or bytes) and is interchangeably carried by the physical entities or digital signs or tokens that one calls money. However, with the introduction of CBDCs, a new, hitherto unexplored dimension of monetary functionality arises: namely, that of *technological* competition. What does this mean?

While currency competition is not a new phenomenon (see e.g. Eichengreen 2005), before the digital revolution, this kind of competition was *not* based on the technological or other physical characteristics of money – we are not talking here about precious metal currencies, but about modern fiat money systems – (coins, banknotes, scriptural money) itself. Quite the contrary: the decisive factors of currency competition were, among other things, as mentioned above, the general economic performance of the currency area, the set of characteristics of the respective money suppliers, i.e. the architecture of the money system, and the choice of the exchange rate regime (Endres 2009). One should state here that a claim against a central bank expressed in monetary units is always 'backed'

by a state. It is hence the interplay between the competitive performance of an economy, the reliability of monetary and economic policy and the sustainability or realism of fiscal policy which influence the relative advantage of one currency to another. In any form of fiat money system, the physical form of money, i.e. its technology in the narrower sense, did not play a role.

However, with the technological progress in past decades, the set of factors of competition now include *the technology itself* that lies behind the functioning of the respective CBDC. This technology may become a factor of interstate currency competition on the one hand and of competition with crypto-assets as well. This does not create a new monetary function, but it does add a new technological dimension to the existing ones. First and foremost, this concerns the function of a medium of exchange. Only if we take this complement seriously does the European Central Bank's argument make sense that it is aiming for "financial innovation" (ECB 2022) and wants to improve "the overall efficiency of the payments system" (ibid.). Relatively cheaper, faster or safer transactions will make a currency more attractive.

But whatever the role of commercial banks in a monetary system with CBDCs may be, a CBDC would compete with any forms of payment that are not made with "real but digital" central bank money, even within one currency area. The extent to which a CBDC could then actually serve "the increasing demand for safe and trusted electronic payments" (ibid.) better than the current intermediaries can is an open and initially technological question. Another question is to what extent a CBDC would be favoured in international transactions due to its technological advantages – such as guaranteed anonymity, speed of transactions, access to a central bank money account, etc. – and thus influence international currency competition, including competition with "digital currencies". This is a theoretical option, but it does exist: and it is a novelty on this scale.

One might say that a kind of *technological competition* would become a decisive parameter of CBDCs with respect to the functionality of money.²¹ This characteristic lies in the technological realisation and the technological design of the CBDC itself, and it is partly independent from the traditional factors of currency competition. And this is an unprecedented phenomenon: never before has money itself carried such a function. We are still at a very early phase of the development of CBDCs and so far no universally usable CBDCs have been introduced. However, when developing CBDCs, central banks should bear in mind that this development will

²¹ If a CBDC offers no functional advantages, introducing one requires other aspects of justification. Waller (2021:6) has drawn attention to this problem with reference to the US banking system: "I remain sceptical that a Federal Reserve CBDC would solve any major problem confronting the U.S. payment system". The problems he addresses are easily transferable to other currency areas. We cannot go into the relevant opportunities, risks and trade-offs here, as this would neither benefit nor detract from the focus of this contribution.

irreversibly supplement the set of functions of money known before. The following section attempts to segment the areas of impact of this new type of competition.

4.4. Areas of CBDC competition

In what manner technology serves as a new complement to money functions can be derived from the technological *design* of a CBDC. *Chen et al. (2022)* identify six key aspects of CBDC design: (1) the degree of interoperability, (2) the degree of central bank involvement in the operation of a CBDC (which we do not address in this paper as it does not influence (technological) currency competition by any means), (3) if the CBDC bears interest, (4) potential constraints on transaction amount, (5) data governance policy, and (6) underlying technology. In the following, we describe how the relevant aspects contribute to the pre-existing factors of currency competition.

(1) Interoperability

Interoperability is a core issue of the digital economy (see e.g. *Kerber – Schweitzer 2017:40*). In our focus, in simple terms it can be summarised as the ease of the flows between CBDCs and other payment systems (*BIS 2021*). It comes across both on a domestic level (i.e. flows between domestic payment systems) and on an international one (i.e. cross-border flows between international payment systems; *Chen et al. 2022*). The more interoperable a CBDC (both on the national and the international levels), the higher the incentive for its widespread use. This aspect is the actual core of technological currency competition. Its economic significance lies in the potential for lowering transaction costs (in the sense of transaction cost theory) for the users of such a currency. As relevant research has shown, it is useful in this respect to distinguish between the competitive effects potentially unfolding between *wholesale* and *retail* CBDCs.

The extent to which the use of retail CBDC would be more convenient for the end consumer than cash, as *Kóczyán et al. (2022:9)* assume, would first have to be proven in practice, especially since this aspect represents only one of a series of factors determining the respective preference, which first have to be determined empirically. *Boros – Horváth (2022:511)* have pointed out that “(...) the instant payment systems already in use efficiently satisfy customer needs”. Moreover, in view of the relatively small amount of cash in relation to the amount of fiat money or the central bank money as a whole (M0 according to Fed), it would be questionable to what extent this competitive element would really be decisive in the sense of currency competition.

By contrast, it seems much more plausible that the technological advantage of a CBDC becomes relevant in a wholesale variant by enabling direct payments between banks in different countries (see for example *Boros – Horváth 2022:511*) and thus

a considerable reduction of previously unavoidable transaction costs (see *World Bank 2022*) can be achieved.

(2) Interest bearing

Jurisdictions where interest bearing (retail) CBDCs are issued have a comparative advantage vis-à-vis those issuing a CBDC that does not bear interest. This is actually not a form of technological competition, but the use of a traditional monetary policy instrument *that goes beyond the concept of a CBDC as a digital complement to cash*. Admittedly, this option raises a number of important questions that go beyond the aspect of technology addressed here.²²

(3) Constraints and data governance policy

We treat these two factors combined (while *Chen et al. 2022* discuss these separately). From the perspective of currency competition, both factors represent a *trade-off between efficiency and safety*. Constraints on the transaction amounts contain a dilemma in themselves: while the aspects of ease and efficiency indicate that no constraints should apply (as these would cause a disadvantage vis-à-vis cash transactions), the aim of preventing illegal and illicit transactions speaks in favour of quantitative restrictions. Quantity restrictions are not only common when withdrawing cash, but also, for example, in transactions with physical gold for private individuals.

Now, the option of quantity restrictions would of course be economically rational from the point of view of monetary policy, insofar as it could counter inflationary developments (i.e. savings could not be spent if inflation was expected). Ultimately, it is the aforementioned economic facts that influence the extent to which such quantitative restrictions play a role at all. If the monetary policy of a currency zone is stable in conjunction with the other factors mentioned, then there is no reason to limit quantities. If not, users could expect such restrictions. However, those who really care about the anonymity of their transactions will find a way to choose another payment method anyway, starting from the scale that is to be pursued at all. However, the aforementioned trade-off does not even have to occur, if the respective economy is competitive, if the monetary and economic policy are reliable and if fiscal policy is sustainable.

Similarly, a trade-off arises between granting users' anonymity and limiting illegal activities. While the outcome is yet unclear and the debate on CBDC-related privacy matters is still ongoing (see e.g. *Darbha – Arora 2020; Jabbar et al. 2023*), these aspects will contribute to the competition between central bank digital currencies.

²² Of course, the focus is primarily on the effects on the activities of commercial banks. There is a broad discussion on this, but it does not provide a uniform picture.

It should not be forgotten in this discussion that any data protection is always an object of politics and therefore never carved into stone, nor that anonymising and keeping anonymous any data is an extremely challenging technological problem. Anonymous data can also be re-identified (*OECD 2020:10*, with reference to *PCAST 2014*). This is also a very challenging technological problem, but its role in the context of technological monetary competition also depends heavily on political preconditions.

(4) Technology (DLT/CLT²³)

The technology on which a CBDC is based is by definition the most relevant factor of technological currency competition. As both central banks and private actors are actively researching this matter (see e.g. *Mori – Pizzamiglio 2023; Chen et al. 2022*), in this paper, we would rather not try to predict the emerging consensus on the technology (distributed or central ledger technology) that will become the most widely used. Ultimately, this is not about technological problems in the narrower sense: just as a contribution on the problems of a gold currency will probably focus less on casting technology. The question is to what extent the technological basis actually enables the additional technological parameters of currency competition, i.e. in the numbering here, above all (1) and (3). Whatever technology it will be, it will remain in the hands of a central bank for a CBDC and thus be inextricably linked to the aforementioned problems of the economy and politics of a currency area.

5. Conclusions

To what extent would a CBDC change currency competition? As we have shown, the new technology represents an additional parameter in competition. It is a new complement to monetary functions. This aspect is new in the history of fiat money, in which the technological properties of the concrete medium of money were basically irrelevant as long as all functional requirements could be fulfilled. In this respect, digital technology *adds a new functional dimension* and increases the complexity of competition.

Currency competition *per se* has been a widely accepted and researched phenomenon: so far, however, the *stability* of money was the key factor when assessing the value of competing currencies. Acceptance of a currency primarily depended on its stability, as both devaluation and revaluation affect certain groups negatively (*Hayek 1976*), while generally, unexpected and considerable fluctuations in the value of a currency increases transaction costs no less. This aspect of currency competition will exist as long as currencies exist, and will not become less relevant. Technological competition as a factor of (international) currency competition

²³ DLT: distributed ledger technology, CLT: central ledger technology

complements to the aspect of stability rather than substituting it (but with the possibility of influencing pre-digital factors of currency competition).

The technology becomes relevant primarily with regard to its potential to reduce transaction costs, for example through higher speed in payment transactions, in whatever way this is realised technologically. However, the fact that the digital version of a central bank currency can be used at all and thus become a competitive medium is linked first and foremost to its interoperability. In this context, it must be emphasised that a competitive effect through the new technology will primarily be able to enfold with the wholesale variant of CBDCs and, initially, hardly at all with a retail variant of CBDCs. However, for even if one CBDC is much more interoperable and easier to use and can thus be paid around the globe much more quickly, this does not mean that the other conditions that have always been relevant for a stable, i.e. *competitive* money would weigh less.

In this respect, the technological parameter is actually the relevant competitive factor, but it is ambivalent. Because no matter how much one may trust the corresponding data governance policy, data protection is and remains the subject of politics. Public pronouncements are one thing, the other is the extent to which they are believed and to which extent promises are kept. Last but not least, it is precisely the non-governmentality *and* anonymity of the private crypto-assets that is trusted by investors – even if this aspect is a trade-off to stability, the core of currency competition.²⁴ In other words, it does not seem economically plausible that the technological superiority of one CBDC alone would sap the purchasing power of another currency, as long as the latter better fulfils the basic – traditional and pre-digital – requirements for stable money.

However, the complementing of money functions is thus remarkable in that it increases the complexity of currency competition, but at the same time increases the possibilities of political (governmental) spillovers. In this respect, it remains an open question whether digitalisation does indeed enhance the competitiveness of a currency. Especially, as central bank currencies – may they be digital or not – face competition from private digital money to a decisive degree not because of the technology, but due to their fulfilment of certain monetary functions. Thus, while technological competition has indeed arisen as a factor of currency competition, other factors such as stability and privacy still matter and might even matter as much or more.

²⁴ While this aspect is out of the scope of this paper, we highly encourage further research on these aspects, the link between the development of CBDCs and data protection and privacy issues. This is a question particularly worth analysing as anonymity is why cryptocurrencies are attractive to many investors and thus an aspect that can on the long run also become an element of currency competition.

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Payment Liquidity in the Light of Changes in the Central Bank Toolkit*

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This study examines the impact of the changes implemented by the Magyar Nemzeti Bank in the central bank toolkit on the liquidity of payment system¹ participants over the period between 2020 and the end of 2023 H1. In response to the economic challenges of recent years, the central bank toolkit changed significantly during the period under review. While the economic and financial crisis stemming from the Covid-19 pandemic required interbank liquidity expansion measures, in 2022 steps to absorb excess liquidity were necessary to fine-tune monetary transmission and achieve and maintain price stability. The analysis focuses on the impact of specific toolkit adjustments on the liquidity of the payment system, while also demonstrating why interbank liquidity is separated from payment system liquidity, and which toolkit modifications have typically had a significant impact on the liquidity of the payment system.

Journal of Economic Literature (JEL) codes: E42, E51, E52, G21

Keywords: monetary policy, payment system, VIBER, payment transactions, liquidity

1. Introduction

Liquidity is an elusive notion in the field of finance, with numerous concepts and definitions being distinguished (Nikolaou 2009). Analyses of liquidity differentiate between central bank liquidity, funding liquidity and market liquidity (Kolozsi – Horváth 2020). As individual liquidity types may differ significantly from one another, it is important to clarify which approach to liquidity is applied in a particular analysis (Goodhart 2008). In this analysis, we examine developments in the aggregate payment liquidity of the direct participants² (hereinafter: ‘participants’) of VIBER (Real-Time Gross Settlement System) in the light of changes in the central bank

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¹ Real-time Gross Settlement System and Interbank Clearing System.

² Under the applicable business terms and conditions, VIBER participants may include, *inter alia*: domestic credit institutions, other payment service providers providing payment services in Hungary, investment firms, financial infrastructure operators (i.e. system operators), CLS Bank International and the MNB.

toolkit, which apply to the counterparties defined in the Terms and Conditions of the Operations of the Central Bank in Forint and Foreign Currency Markets. While this study does not examine in detail the evolution of turnover in VIBER, it should be noted that turnover in VIBER amounted to several times the value of Hungarian GDP in 2020, 2021 and 2022. During the period under review, in respect of the central bank balance sheet, certain modifications to the central bank toolkit can be considered liability-driven, as the relevant international literature points out. These typically include various lending schemes and asset purchase programmes. Some solutions, however, are asset-driven, which are used to absorb excess liquidity via deposit instruments (*Gray 2006*).

The liquidity of VIBER participants is essentially composed of two items. The first component is the payment account balance of participants held with the Magyar Nemzeti Bank (central bank of Hungary, MNB) for the purpose of conducting payment transactions (hereinafter: 'account balance'), which, besides settling payment transactions, is maintained for the purpose of complying with the reserve requirement ratio, as well as the instant settlement account balance (AFR account balance), which may be used for the execution of instant payments. The account balance and the instant settlement account balance can change significantly within a day, as they are constantly being modified by the participants' payment transactions. These balances are augmented by payment transactions entailing revenues for the specific participant; moreover, the central bank instruments applied for monetary policy purposes, such as overnight or other short-term deposit instruments, can modify the balances significantly. This is because recourse to these instruments and the fixing of the stocks concerned typically take place in the hours leading up to the closing of VIBER, while the next day's release takes place in the period after the opening of VIBER. Consequently, the balance as at the closure and opening of VIBER may not necessarily provide an accurate view of the amount of liquidity available for intraday use. The second component of liquidity is the intraday credit line received by participants against collateral pledged to the MNB, which is equal to the portion of the pledged collateral that can be used for payment transactions. The availability and use of the thus allocated credit line is free of charge during the day (*MNB 2023a*). The part of the pledged collateral that can be used for payment transactions is also determined by the Terms and Conditions of the Operations of the Central Bank in Forint and Foreign Currency Markets. As mentioned above, it is also important to note that, in addition to VIBER liquidity, the instant settlement account balance reserved for instant payments in the Interbank Clearing System (hereinafter: 'ICS') also expands the liquidity of the payment system. With the launch of instant clearing in March 2020, there was a change in the VIBER balance of accounts, but it is also important to note that the launch of the new payment solution did not reduce the liquidity of the payment system; it was simply split into a VIBER balance of accounts and an ICS instant settlement account balance.

The sum of these items determines *the liquidity of the payment system, which may be different from the liquidity of the banking sector or the financial system used for the purposes of monetary policy*, and indeed, their volume may diverge in response to changes to the central bank's monetary policy instruments. An example of this was seen in October 2022, when the long-term liquidity-absorbing deposit,³ activated as part of a central bank toolkit modification, was used to sterilise interbank liquidity, but as it was included in the scope of eligible collateral for payment transactions, it increased the intraday credit line and payment liquidity. In the period 2020–2023, eligible collateral also included government bonds, discount Treasury bills, mortgage bonds, investment units, bonds, foreign issued Hungarian securities, corporate loans, long-term liquidity-absorbing deposits, interest-bearing Treasury bills and the collateral value of SME loans issued under the Funding for Growth Scheme (FGS), although the latter was not eligible as collateral for payment transactions.⁴

In the analysis, we examine the modifications to the central bank toolkit after 2018 and 2019, which were relatively balanced years in terms of liquidity, as these changes had significant impacts in some cases. In addition to tracking the changes in the account balance, the instant settlement account balance and the intraday credit line, we also examine the evolution of the pledged collateral portfolio, the portfolio of overnight and other short-term deposit facilities and any transaction queues and maximum utilisation of the intraday credit line (MICL) arising in the VIBER system. The primary objective of the analysis is to identify the scope of central bank toolkit modifications that may have a major impact on liquidity.

2. Methodology

2.1. Payment systems under review

VIBER is a domestic payment system operated by the MNB, primarily for the settlement of high-value⁵ urgent, HUF-based payments, which are final and irrevocable once they are settled automatically in real time, in accordance with the provisions of Act XXIII of 2003.⁶ Money market operations – i.e. the so-called interbank items – account for the bulk of the turnover. VIBER participants are institutions that hold an account with the MNB. Payment orders are executed subject to the availability of sufficient collateral. The collateral is the positive account balance and the intraday credit line provided by the MNB based on the collateral pledged for payment transactions, and the intraday credit line can be adjusted

³ A floating-rate deposit facility with a maximum tenor of 6 months.

⁴ The exact definition of eligible collateral is determined by the Terms and Conditions of the Operations of the Central Bank in Forint and Foreign Currency Markets.

⁵ In 2022, the average transaction value was HUF 1,267 million.

⁶ Act XXIII of 2003 on Settlement Finality in Payment and Securities Settlement Systems.

during the day. Efficient liquidity management is supported by the central queue management system, the use of priorities, the algorithm unlocking gridlocks, and the VIBER Monitor service (*MNB 2023b*). VIBER's Central Accounting System (CAS) distinguishes a number of priority codes, which VIBER participants use to prioritise the payment orders they initiate, thus facilitating the smooth execution of payment transactions. Pending, non-rejected payment orders are queued in CAS according to their priority relying on the queue management mechanism, and CAS notifies the participant if the transaction at the top of the payment queue does not move for 90 seconds due to insufficient funds. Gridlock occurs if the payment orders of two or more participants are in a queue due to insufficient funds while they have a debt to each other. Gridlocks can be resolved by supplying more liquidity or by using a gridlock resolution algorithm. The frequency of starting the algorithm can be parameterised; at present, it checks queued transactions every 10 minutes, while ensuring that the sequence of payment orders does not change during the process. The VIBER Monitor service enables participants to obtain information on their queuing and executed transactions and to modify, delete or re-prioritise their queuing orders (*MNB 2023a*).

The ICS processes and clears domestic interbank payment transactions in HUF. There are three different platforms for clearing services: overnight clearing, intraday clearing and instant clearing. While in the case of overnight clearing a transaction submitted before midnight will only be cleared on the next business day, in the case of intraday clearing, items will be cleared on the day of the transaction, unless exceptional circumstances arise.⁷ With instant clearing, transactions are not cleared in batches but on a fully individual basis 24 hours a day. Instant transactions – which have a HUF 20 million limit from 1 September 2023⁸ – are covered from the originator clearing member's instant settlement account balance (*GIRO 2021*).

The liquidity in VIBER and the ICS is essentially determined by the same factors; therefore, any changes in these factors may equally affect both systems and their participants. While the intraday and overnight clearing of the ICS is settled in VIBER from VIBER's payment liquidity, settlement in the case of ICS instant clearing is different, resulting in partial sharing of the liquidity between the platforms that settle payment transactions. In the case of instant clearing, participants pre-finance the funds on a technical omnibus account held with the MNB, and the balance of participants' instant settlement account are registered by GIRO Zrt. on behalf of the MNB. In addition to the transactions executed, the value of such can be adjusted by transferring the VIBER account balance, and outside of VIBER operating hours (6 p.m. – 7 a.m.) liquidity can be added by way of central bank lending, i.e. by instant credit provided based on the securities portfolio pledged to the MNB (*MNB 2022a*).

⁷ Two hours is required on average for a transfer to reach the bank account of the beneficiary from the time of debiting the payer's bank account (*Császár 2015*).

⁸ From which the clearing members may deviate upwards on a bilateral basis.

This analysis examines the impact of modifications to the MNB's monetary policy toolkit, focusing on the liquidity of the VIBER and ICS payment systems.

2.2. Raw data and indicators

In its capacity as VIBER's operator, the MNB continuously records key data on the operation and attributes of the system (Bodnár *et al.* 2015). In addition, credit institutions subject to reserve requirements are required by law⁹ to provide statistical balance sheet data to the MNB and accordingly, most of the information needed for this analysis was available, while details on modifications to the central bank toolkit are publicly available on the MNB's website.

The main focus of the analysis is on changes in the end-of-day¹⁰ account balances, instant settlement account balances and intraday credit lines of VIBER participants, as well as changes in the volume of overnight deposit facilities¹¹ (O/N central bank deposit, preferential deposit, QuickTender) in the MNB's central bank instruments. We can extract important information from the changes and fluctuations in these balances, as well as from the co-movement of values. Modifications to the central bank toolkit can significantly alter the relationship between the balance and the intraday credit line, for example, if the scope of the eligible collateral is changed or a decision is made on the reserve requirement ratio. To investigate this interaction, we analysed the correlations between account balances and available liquidity (instant settlement account balance, account balance and intraday credit line) to see the relationship arising from each monetary policy toolkit adjustment between the VIBER account balance, the instant settlement account balance and the intraday credit line.

$$\text{Correl}(X, Y) = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}} \quad (1)$$

x = Sum of end-of-day account balances and instant settlement account balances on a specific day.

\bar{x} = Average of end-of-day account balances and instant settlement account balances in a specific period.

y = Sum of end-of-day liquidity on a specific day.

\bar{y} = Average of the end-of-day liquidity of a specific period.

⁹ MNB Decree No. 10/2005 (VI. 11.).

¹⁰ Pursuant to MNB Decree No. 36/2022 (IX. 15.), the account balances shown on the daily account statement are used for the purposes of calculating compliance with the reserve requirement ratio.

¹¹ Although it has been noted that the balance of overnight central bank deposits should not be used as collateral for central bank credit under the MNB's Business Terms and Conditions, since short-term deposits are typically fixed in the hours immediately preceding the closing of VIBER and are released following the opening of VIBER on the next day, the liquidity is available to VIBER participants during the day; consequently, in order to present the actual account balance, the midnight balances are presented in conjunction with short-term deposit holdings.

Despite the effectiveness of the queue management mechanism, some queuing payment orders occur primarily due to insufficient funds. By analysing queuing developments, we can see from a different perspective whether there is sufficient liquidity in the payment system, because, in addition to examining the static end-of-day status of the VIBER account balance, the instant settlement account balance and the intraday credit line, the number of queuing items provides information on whether payment transactions were executed smoothly during VIBER operating hours (7 a.m. – 6 p.m.), i.e. this analysis provides information on intraday processes. A significant increase or decline in the number of payment orders in the queue following a change in the central bank toolkit may offer important information on the impact of certain adjustments to the monetary policy instruments on the liquidity of the payment system and on payment transactions. However, it should not be overlooked that the liquidity management of individual VIBER participants can vary significantly; therefore, in some cases the number of queuing transactions of a single participant may skew our conclusions about the overall VIBER system.

The analysis of the maximum utilisation of intraday credit line (MICL) serves a similar purpose as the analysis of queuing transactions. If a VIBER participant has insufficient funds on the VIBER account to settle an outgoing payment order, the participants will be entitled to take recourse to an intraday credit line¹² – which is not the same as an overnight (O/N) loan. If the sum of a participant’s intraday credit line and account balance is insufficient to settle the payment order, the transaction will be queued, but it will also provide relevant information if a payment order is settled against a credit line rather than being queued. Similarly, by examining intraday MICL values, we obtain information on the flows, i.e. on the payment transactions that take place during VIBER operating hours, rather than on the static VIBER account balance and the end-of-day closing balance of intraday credit lines.

$$MICL = \frac{FNH}{NH} \quad (2)$$

NH = The daily intraday credit line of a specific bank on a specific day.

FNH = Value of the maximum utilisation of intraday credit line of a specific Bank on a specific day.

¹² The scope of eligible clients is defined in the prevailing Terms and Conditions of the Operations of the Central Bank in Forint and Foreign Currency Markets.

2.3. Horizon under review and relevant key central bank decisions

The analysis studies the effects of modifications to the central bank toolkit in the period between the beginning of 2020 and 2023 H1. Over the selected time horizon, significant economic challenges had to be addressed, and as such, the period under review was particularly active in terms of modifications to the central bank toolkit (Table 1).

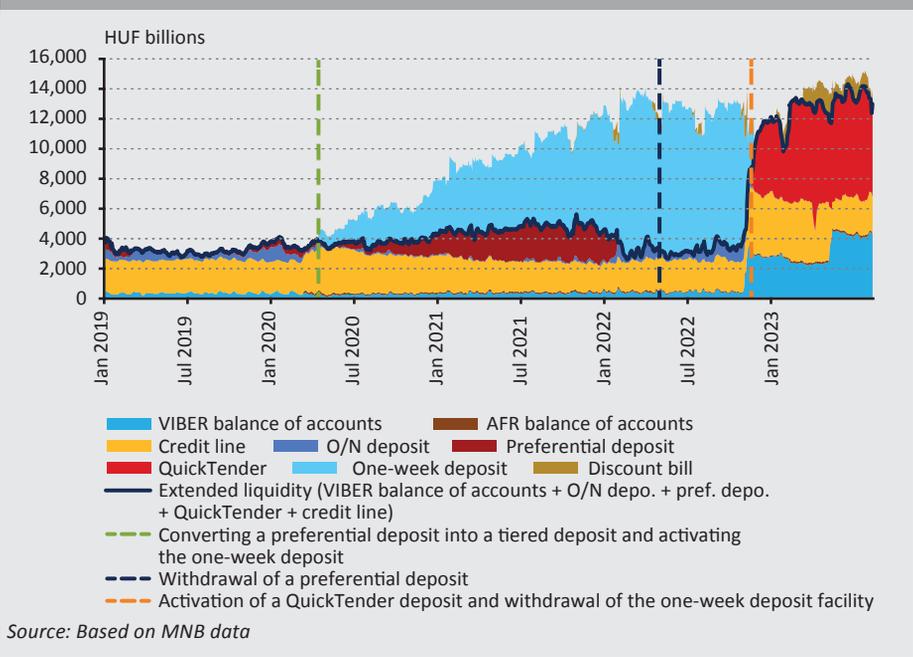
Table 1	
Key central bank decisions affecting the central bank toolkit	
Date	Decision
16 March 2020	Activating one-week FX swap tenders providing forint liquidity to maintain the appropriate level of liquidity for the banking sector and to smooth liquidity developments.
17 March 2020	Expanding the scope of eligible collateral with corporate loans effective from 23 March.
24 March 2020	Introducing a new fixed-rate collateralised loan instrument with maturities of 3, 6 and 12 months as well as 3 and 5 years, with unlimited liquidity. Exemption from the consequences of non-compliance with reserve requirements from the reserve maintenance period starting in March.
1 April 2020	Activating a one-week deposit facility bearing interest at the central bank base rate.
7 April 2020	Making the interest rate corridor symmetrical. Increasing the interest rate on O/N and one-week collateralised loans from 0.9 per cent to 1.85 per cent, while the base rate and the O/N deposit rate remained unchanged. Launching a government security purchase programme in the secondary market, and re-launching the mortgage bond purchase programme.
7 April 2020	Launching the Funding for Growth Scheme Go!, increasing the previous amount by HUF 1,000 billion. Including HUF 500 billion undrawn under the FGS fix scheme, the MNB made available HUF 1,500 billion of cheap and stable source of lending to the SME sector under the consolidated FGS Go! scheme. The maximum maturity of refinancing loans was increased from 10 years to 20 years, and the maximum loan amount available to SMEs was raised to HUF 20 billion from HUF 1 billion.
7 April 2020	Raising the maximum amount of exposure to a given group of corporations from HUF 20 billion to HUF 50 billion under the Bond Funding for Growth Scheme. Raising the maturity of securities eligible for purchase under the scheme from 10 to 20 years. Converting the preferential deposit facility into a tiered interest rate facility.
30 April 2020	Accepting investment units as collateral.
August 2021	Launching the Green Mortgage Bond Purchase Programme.
1 September 2021	Removing investment units from the scope of eligible collateral.
1 April 2022	Phasing out the preferential deposit facility.
1 October 2022	Activating the long-term liquidity-absorbing deposit. Raising the required reserve ratio to 5 per cent and reintroducing the penalty for reserve balance deficiency.
14 October 2022	Activating the QuickTender. Phasing out the one-week deposit facility.
1 April 2023	Raising the reserve requirement ratio to 10 per cent.
<i>Source: MNB</i>	

2.4. Overview of the central bank toolkit for the period under review

During the period covered by the analysis, a number of central bank deposit facilities were available to VIBER participants under various schemes, which, as mentioned above, may have had an impact on developments in payment liquidity. In this part of the analysis, we present the extent to which certain deposit facilities may have influenced changes in the volume of payment liquidity.

As mentioned before, the main focus of the analysis is on changes in the end-of-day account balances, instant settlement account balances and intraday credit lines of VIBER participants, as well as changes in the volume of overnight deposit facilities (O/N central bank deposit, preferential deposit, QuickTender) in the MNB's monetary policy instruments.

Figure 1
Developments in VIBER participants' account balances, instant settlement account balances, intraday credit lines and extended liquidity and in the MNB's deposit facilities between 2019 and 2023 H1



In the analysis the evolution of extended liquidity will be described in detail; in this section we present elements that belong neither directly to the 'classical' components of payment liquidity that we have examined in detail,¹³ nor to the

¹³ The classic elements include, *inter alia*, the account balances and the intraday credit line mentioned above.

category of overnight (O/N) deposit instruments. Among the instruments shown in *Figure 1*, one-week deposits and discount bills are not available intraday to VIBER participants for their payment transactions, and are not included in the collateral eligible for acceptance by the MNB, and as such, they did not increase the intraday credit line. In the analysis, these portfolios were not included in the extended liquidity, but it is important to note that the one-week deposit in particular – which peaked at over HUF 10 billion in mid-2022 – provided a form of liquidity buffer that, if properly planned, allowed VIBER participants to transfer significant amounts of funds on a weekly basis into instruments that enabled them to execute payment transactions. Similarly, from the perspective of payment liquidity, discount bills – which, except for a few cases, are typically announced with a maturity of 1 week – are instruments which include some portfolios that may be channelled into liquid assets on a weekly basis if needed.

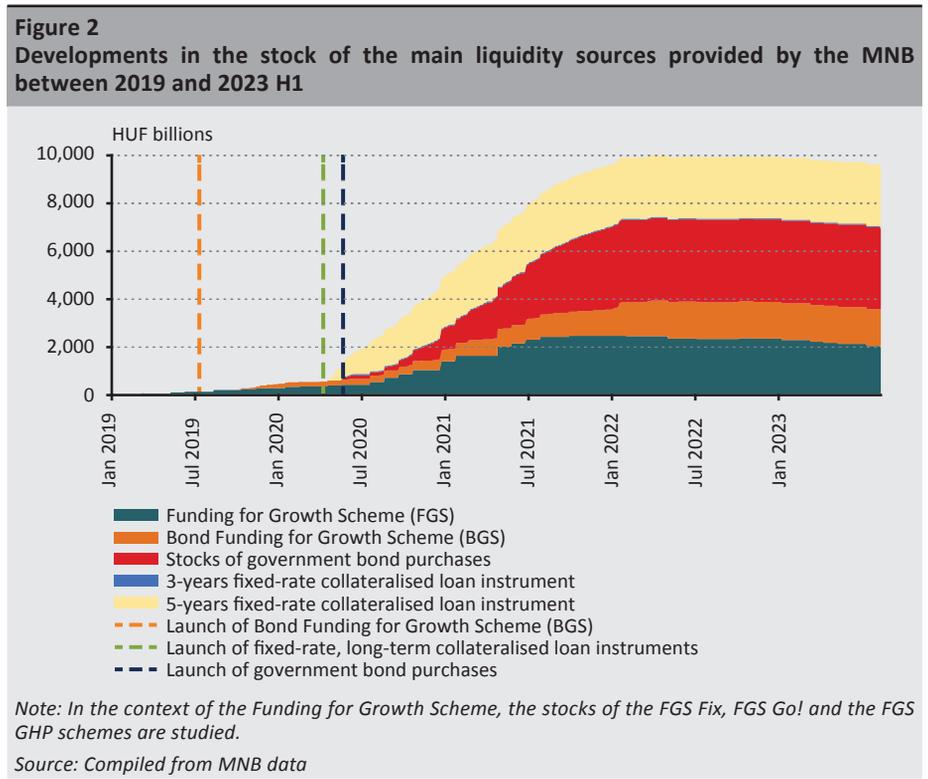


Figure 2 shows the main sources of liquidity provided by the MNB, through which part of the liquidity injected into the banking sector could also be channelled into some elements of the liquidity of the payment system. The Funding for Growth Scheme was announced by the MNB in 2013 in order to mitigate the disturbances in lending to small and medium-sized enterprises, to strengthen financial stability

and to reduce Hungary's external vulnerability. With the FGS Fix Scheme, which was launched on 1 January 2019 as part of the FGS, and the FGS Go!, which commenced on 20 April 2020, the MNB aimed to improve the health of the domestic SME lending structure by easing access to long-term, fixed-rate loans for micro, small and medium-sized enterprises. The last addition to the FGS came on 4 October 2021, when the MNB launched the FGS Green Home Programme (FGS GHP) for the purpose of promoting the integration of environmental sustainability (green) aspects into the domestic housing market, which may also contribute to stimulating demand for green homes and thus to also boosting the supply (*MNB 2022b; MNB 2022c; MNB 2022d*). Launched on 1 July 2019, the Bond Funding for Growth Scheme (BGS) aimed to help diversify domestic corporate debt by raising the liquidity of the corporate bond market, thereby enhancing the effectiveness of monetary transmission (*MNB 2022e*). In accordance with the 7 April 2020 decision of the Monetary Council, the MNB launched a secondary market government bond purchase programme. In the framework of the government bond purchase programme, the MNB announced a variable-price government bond auction from 4 May 2020 until further notice, and purchased fixed-rate, HUF-denominated government securities in the form of spot securities sales on the secondary market, thus improving the liquidity supply of the banking sector (*MNB 2020c; Ábel et al. 2016*). In order to ease the financial market strains caused by the Covid-19 pandemic, on 24 March 2020 the Monetary Council decided to take liquidity-providing measures. The MNB introduced a new fixed-rate collateralised loan instrument with maturities of 3, 6 and 12 months, as well as 3 and 5 years, with an unlimited credit line. The long-term collateralised loan instrument provided banks with a predictable, fixed-rate source of funding, supported liquidity in the corporate and household credit markets and in key financial markets, helped to mitigate financial market turbulence and contributed to the stability of the financing environment (*MNB 2020a; MNB 2020b*).

3. Findings

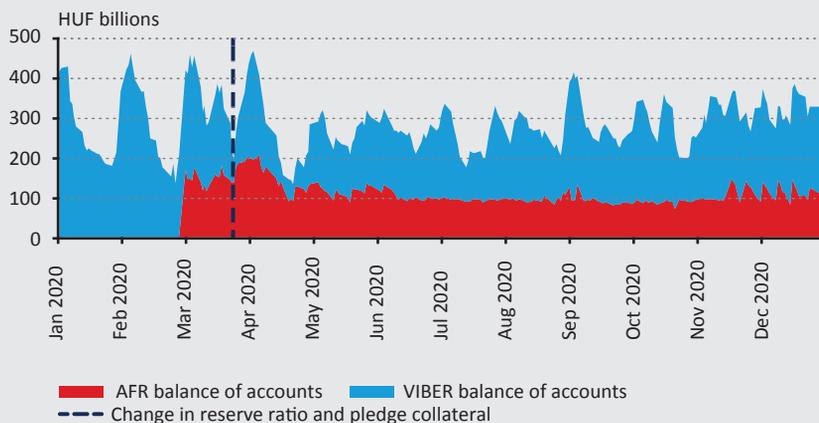
3.1. The year 2020

In response to the market turbulence caused by the Covid-19 pandemic in 2020, in March and April the MNB implemented a number of changes in its central bank toolkit. In order to increase the liquidity of the banking sector, several decisions were made such as exempting VIBER participants from the legal consequences of non-compliance with the reserve requirement, expanding the scope of eligible collateral, activating new loan and deposit facilities, introducing a programme for the purchase of government securities on the secondary market and launching the Funding for Growth Scheme Go! (*Table 1*).

In parallel with these modifications to the central bank toolkit, the liquidity of the VIBER payment system increased from HUF 2,300–2,500 billion at the beginning of

the year to HUF 3,000–3,100 billion in 2020 Q2, and stabilised at HUF 2,700–2,800 billion by the end of the year. By contrast, the volume of the extended liquidity rose to nearly HUF 4,500 billion from HUF 3,800 billion during the year, thanks to the intraday availability of funds deposited to preferential deposits for payment purposes. This central bank instrument was converted to a tiered-rate facility in May 2020. The midnight level of the VIBER balance of accounts dropped sharply during the year, partly in relation to the launch of the instant clearing of the ICS, as technically speaking, the liquidity used by participants for instant payments is separate from the VIBER account balance. In consideration of interbank payment methods, from a flow perspective, the launch of instant payments technically splits the liquidity needed for execution, but overall this separation does not affect participants' payment liquidity. The decision of 24 March, namely, that non-compliance with the 1-per cent reserve requirement ratio will not lead to legal consequences, played a major role in the decline in the midnight level of the VIBER balance of accounts. A comparison between the average midnight levels of the account balances for the three weeks preceding (2 March – 22 March 2020) and the three weeks following (25 March – 15 April 2020) the effective date of the decision on the reserve requirement reveals that the decline amounted to 32.4 per cent. As a result, the level of the VIBER balance of accounts decreased significantly (Figures 3 and 4).

Figure 3
Aggregated, midnight account balance and aggregated, midnight balance of the instant settlement account (AFR) of VIBER participants – 2020



Note: Of the HUF 400 billion payment system account balance as at 1 September, HUF 307 billion is the VIBER balance of accounts, while HUF 93 billion is part of the instant settlement account balance.

The 1 May 2020 modification to the central bank toolkit is not included due to its low impact on payment system liquidity.

Source: Based on MNB data

The significant changes in the instant settlement account balance (AFR account balance) are mainly due to the adjustment period following the implementation of the system. This shows that participants maintained a higher balance on their instant settlement account on average than would have been justified by their transactions.¹⁴ Modifications to the central bank toolkit did not have a clear impact on the instant settlement account balance.

In order to address the market turbulence caused by the Covid-19 pandemic and to increase liquidity, effective from 27 March 2020 the MNB extended the scope of eligible collateral to include corporate loans, investment units, and HUF-denominated corporate bonds and mortgage bonds with contracted market makers.

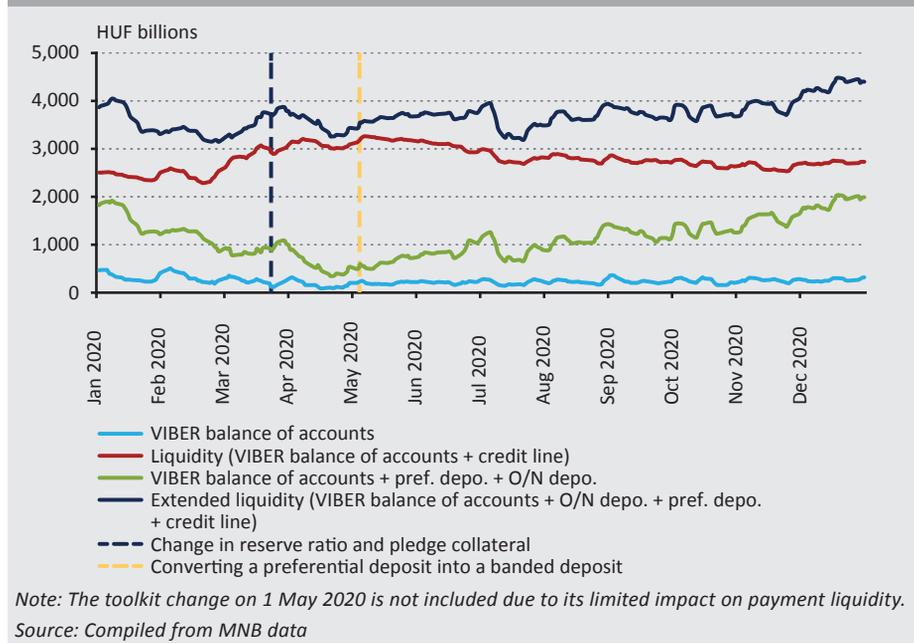
In addition to the liquidity-providing measures adopted by the central bank, the 10-per cent rise in the liquidity of VIBER in 2020 also reflects the increase in the eligible collateral, as the payment liquidity of VIBER is composed of the account balance on the one hand and of the intraday credit line on the other hand (i.e. the part of the pledged collateral that can be used for payment purposes). The decline in the balance of accounts on the back of the change in the reserve requirement ratio was offset by the increase in the collateral volume from 2020 Q2 (*Figure 5*). The primary objective of the change in the reserve requirement ratio was to partially release liquidity in the banking sector. The 14-per cent change in the extended liquidity value during the year was due to a change in the conditions for the preferential deposit, the volume of which amounted to HUF 1,500–1,600 billion per day by the end of 2020, thanks to the activity of VIBER participants.

In the first two months of 2020, midnight account balances (the payment account balance and the instant settlement account balance) and payment liquidity exhibited a high correlation (0.73), and then, following the toolkit modifications affecting the reserve requirement ratio and the scope of eligible collateral, as well as the launch of instant clearing, the co-movement weakened for the remaining 10 months of the year, showing a correlation value of 0.16. This also demonstrates that various modifications to the monetary policy instruments may have different effects on the individual components of liquidity. While the easing of the reserve requirement ratio reduced the VIBER balance of accounts, extending the scope of eligible collateral increased the intraday credit line; thus, overall, developments in the liquidity of the VIBER system reflected the simultaneous occurrence of different effects. It should be noted that, examining the same relationship between the account balance (supplemented by the portfolio of preferential and O/N central bank deposits) and the extended liquidity

¹⁴ This is also due to the cost of taking recourse to the instant credit instrument, because while a VIBER member can use its intraday credit line free of charge – as long as it is repaid by the closure of VIBER – at present, the interest rate on instant credit equals the O/N lending rate plus 200 basis points. See: *Announcement on fees, extra fees, commissions, postal and other costs on payment orders other than cash transactions relating to bank accounts managed by the Magyar Nemzeti Bank, and the order of discharging fees, costs and interest, as well as FX exchange rate margins.* <https://www.mnb.hu/letoltes/hirdetmeny-20240101.pdf>. Downloaded: 31 January 2024.

level, we find that prior to the decision on the reserve requirement ratio, the co-movement of the account balance and the extended liquidity showed a correlation of 0.99. This indicates that the value of preferential deposits and O/N deposits play a highly dominant role in liquidity during the operating hours of VIBER, while the correlation value dropped to 0.84 after the change in the required reserve ratio. This is because, despite the dominant role of the preferential deposit and the O/N deposit, changes in the intraday credit line and the midnight account balance had already reduced the co-movement, albeit only moderately.

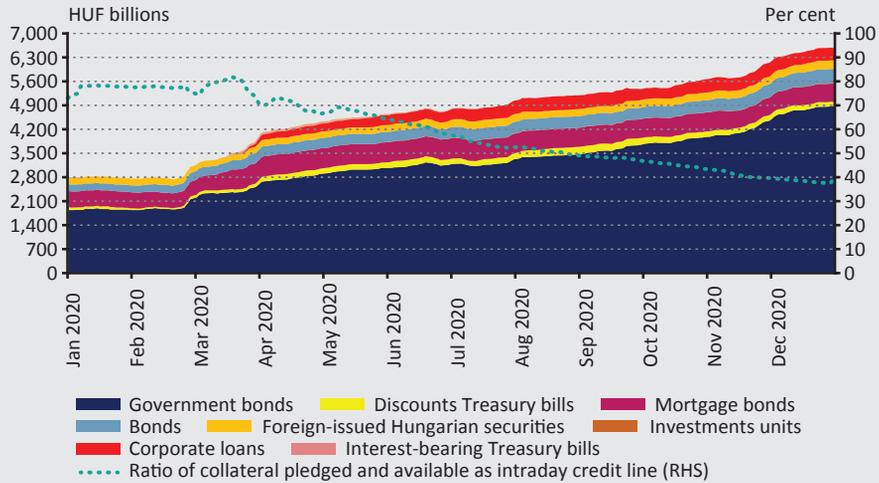
Figure 4
Aggregate midnight and extended account balances and liquidity of VIBER participants – 2020



The expansion of the liquidity of the VIBER payment system is also partly due to the increase in the scope of eligible collateral. In order to boost interbank liquidity, the MNB extended the scope of eligible collateral to corporate loans from 27 March 2020, and to investment units from 1 May 2020 (Figures 4 and 5). Accepting loans as collateral generates information for the central bank on the quality of commercial bank loans, which helps the central bank to rapidly provide liquidity in the event of a liquidity shock (Koulischer – Van Roy 2017).

Partly as a result of the change in the central bank toolkit, the share of mortgage bonds, bonds and foreign-issued Hungarian securities in the portfolio of pledged collateral decreased, while the share of government securities rose to 73.33 per cent from 65.55 per cent. By the end of the year, corporate loans accounted for 5.81 per cent of the value of pledged collateral (Figure 6, MNB 2021).

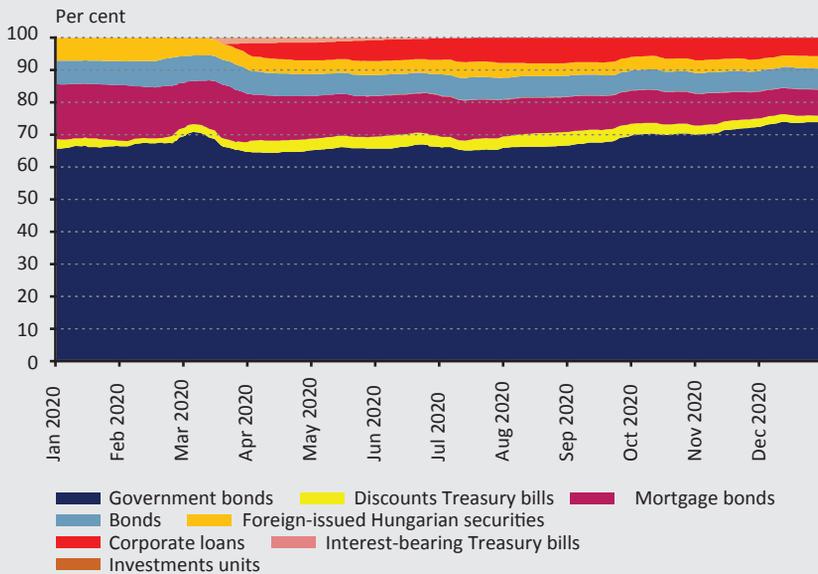
Figure 5
Ratio of pledged collateral to the intraday credit line – 2020



Note: For the ratio of intraday credit line: Ratio of credit line available for payments to the total portfolio of pledged collateral (excluding the collateral value of loans disbursed to SMEs under the FGS). 72.9 per cent of the HUF 2,764 billion pledged collateral on 1 January can be used for payment purposes.

Source: Compiled from MNB data

Figure 6
Breakdown of the composition of the pledged collateral portfolio – 2020



Source: Compiled from MNB data

Starting from May, there was a significant contraction in the maximum utilisation of intraday credit line (MICL) in 2020. As a result, the aggregate monthly average MICL of VIBER participants fell from 12.3 per cent in April¹⁵ to 7 per cent in August, before rising again somewhat by the end of the year. This is consistent with turnover, although the change in the turnover data is not that pronounced, showing an average decline of 7.6 per cent from April to August followed by an increase in December. This contraction in MICL values is partly related to the extension of the scope of eligible collateral and the increase in the portfolio of pledged collateral, i.e. the intraday credit line. On the one hand, the higher liquidity available to VIBER participants in the payment system means that the potentially used credit amount – the utilised credit line – represents a smaller share in the credit line, and on the other hand, it indicates that – despite the decline in the level of the account balance – most VIBER participants were still able to execute their transactions from their account balances.

The queuing of VIBER transactions also shows a sharp fall resulting from the changes in monetary policy instruments. It is not enough to assess the impact of the toolkit modifications effected in March and April 2020 on queues simply by comparing the average monthly number of queuing transactions in the first two months of the year to the number of cases observed in the rest of the year. Based on this approach we would find that the changes in the central bank toolkit would have increased the number of queuing transactions by 36 per cent. When the number of queuing transactions in the first two months of 2020 is compared to the corresponding number in the third and fourth months, we find a 25-per cent increase. It is important to note, however, that the vast majority of queuing in 2020 was linked to the liquidity management of a single VIBER participant. Once that particular participant is excluded from the data, it becomes clear that after the changes to the central bank toolkit, the number of queuing transactions dropped by 43 per cent on average in the last 10 months of the year. Compared to the third and fourth months alone, the decline is 55 per cent. It can be said that changes in the central bank toolkit led to a smoother flow of payment transactions in the VIBER system, which, again, was a larger change than that seen in turnover data, where a decline of 5.8 per cent and an increase of 7.2 per cent can be observed, respectively.

3.2. The year 2021

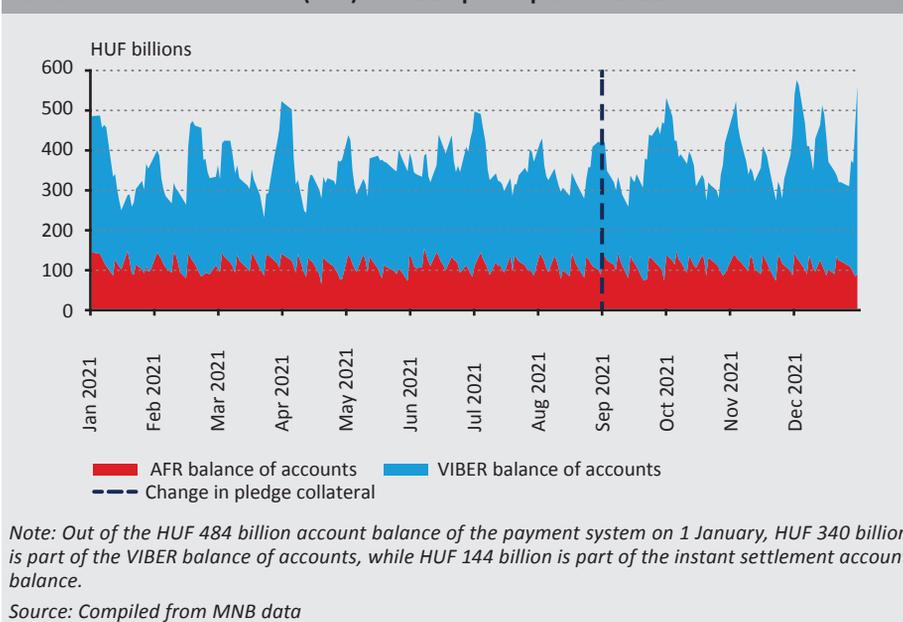
Relative to 2020 and 2022, 2021 was a calmer period in terms of changes to the central bank toolkit. The scope of eligible collateral was modified: from 1 September 2021, investment units were no longer accepted as eligible collateral.

¹⁵ The figure of 12.3 per cent recorded in April 2020 was the highest value seen since January 2014, and the average monthly MICL value of VIBER members was low – adequate – overall, which points to the liquidity adequacy of the system.

The payment liquidity of VIBER participants decreased in 2021, but it was still sufficient to handle their payment transactions. The level of VIBER participants' payment liquidity fell by around HUF 500 billion to HUF 2,200–2,300 billion reflecting a decline in the intraday credit line, which could not be offset by the gradual increase in the account balance. In comparison, there was no significant decline in extended liquidity, which stagnated with minor fluctuations at around HUF 4,500 billion, as the decline in the intraday credit line was offset by the increase in the intraday availability of preferential deposits and O/N deposits during the year (Figures 7 and 8).

The instant settlement account balance showed a cyclical, roughly weekly replenishment pattern during the year, which was influenced by the flow of instant transactions. Thus, during the year, it stood at a level of HUF 100–150 billion, unaffected by the toolkit modification (Figure 7).

Figure 7
Aggregated, midnight account balance and aggregated, midnight balance of the instant settlement account (AFR) of VIBER participants – 2021



By the end of November, the intraday credit line gradually dropped to HUF 1,800 billion from HUF 2,400 billion at the beginning of the year before stabilising at HUF 2,000 billion by the end of the year. The reserve requirement ratio remained unchanged in 2021, but the level of the midnight account balance kept in VIBER increased steadily, fluctuating between HUF 150 billion and HUF 450 billion (MNB 2022a). The change in monetary policy instruments also had no material impact

on the account balance or liquidity, but the weak correlation of 0.58 between the account balances (payment account balance and instant settlement account balance) and liquidity in the first eight months of 2021 strengthened to a correlation of 0.85 in the last four months of the year. That notwithstanding, the change in the scope of eligible collateral had no material impact on the correlation for the reasons explained below. The midnight account balances – including short-term deposits – and the extended liquidity value show significant volatility throughout 2021 due to changes in the stock of preferential deposits. The stock of preferential deposits fluctuated between HUF 1,276 billion and HUF 2,906 billion during the year, but the fluctuations were also driven by the volatility of O/N deposit stocks, with minimum-maximum values ranging between HUF 17 billion and HUF 800 billion. In respect of correlation between the midnight account balances – including short-term deposits – and the extended liquidity value, the toolkit modification had no significant impact: while the correlation for the first eight months of 2021 is 0.96, the correlation for the last four months of the year after the modification is 0.99, which can be attributed to the high volume of preferential deposits and O/N deposits, as in 2020 (Figure 8).

Figure 8
Aggregate midnight and extended account balances and liquidity of VIBER participants – 2021

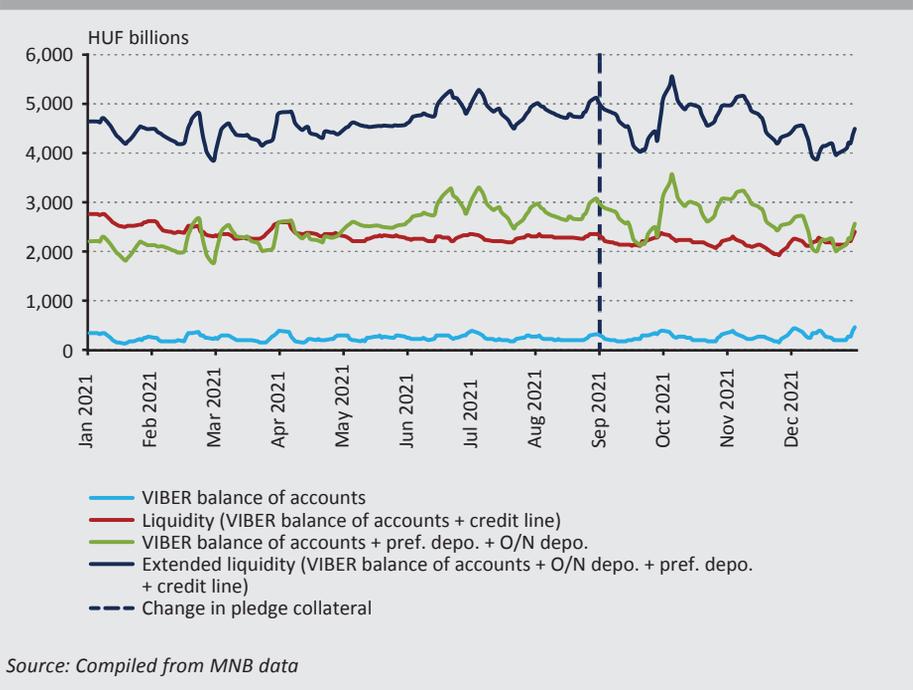
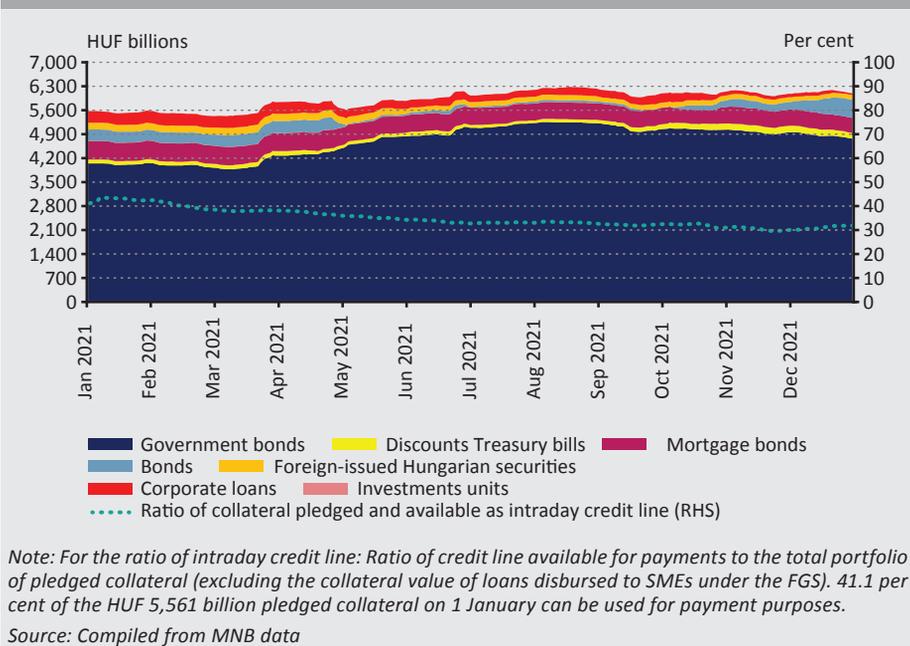
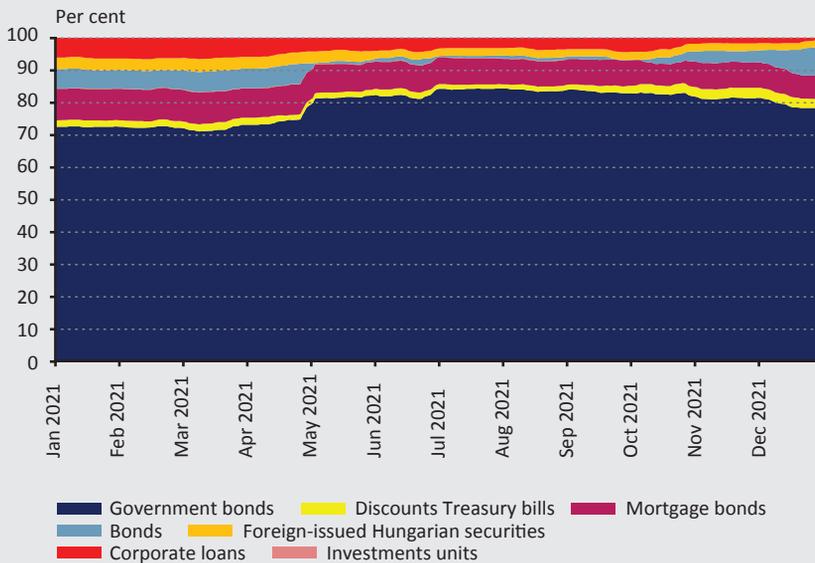


Figure 9
Ratio of pledged collateral to the intraday credit line – 2021



The change in the scope of eligible collateral effective from 1 September 2021 had no material impact on the liquidity of the payment system. Starting from 1 September, HUF-denominated investment units were excluded from the scope of eligible collateral, representing HUF 7.3–HUF 7.6 billion since the beginning of their eligibility on 29 May 2020, and thus accounting for 0.09–0.15 per cent of the total portfolio of pledged collateral over the 15-month period. The removal of forint-denominated investment units from the scope of collateral did not have a material impact on the liquidity of the payments system as a whole. It is important to note that, although the total stock was linked to a single VIBER participant, in the case of that participant investment units accounted for only 1.87 per cent of pledged collateral on average (29 May 2020 – 1 September 2021). As a result, the modification did not give rise to liquidity risk even at the individual participant level, nor did it result in queues. The composition of the pledged collateral behind the intraday credit line has changed somewhat. Starting from April 2021, the share of government bonds gradually increased by 10 percentage points to reach 80 per cent of pledged collateral, while the share of corporate loans contracted sharply (Figures 9 and 10).

Figure 10
Breakdown of the composition of the pledged collateral portfolio – 2021



Source: Compiled from MNB data

Similarly, the toolkit modification had no significant impact on the MICL value of VIBER participants during the year, although the monthly averages of the maximum utilisation of intraday credit line showed an increase after the modification: the monthly average rose to 6.2 per cent in September and 7.7 per cent in October from the average of 5.3 per cent recorded in August. However, for the reason explained in the previous paragraph, the reduction of the scope of eligible collateral had no significant systemic impact on the evolution of credit line utilisation. The trend in turnover values is consistent with the change in MICL values, with a 6.4-per cent increase in September and another 3.6-per cent increase in October relative to the average recorded in August. However, the average MICL value of the participant applying investments units rose to 0.357 in the first two weeks of September from 0.312 in the last two weeks of August, partly reflecting the reduced daily credit line resulting from the toolkit modification.

3.3. The year 2022

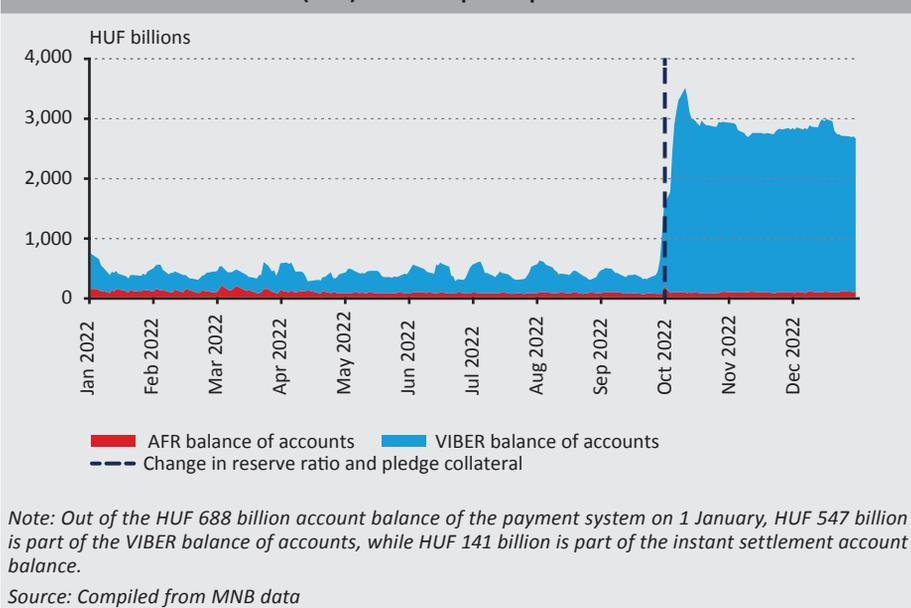
In 2022, the MNB implemented significant modifications to its monetary policy instruments in order to maintain price stability, to keep the closely related interbank liquidity at an optimal level (*Ganley 2002*) and to reduce the impact of financial market turbulence on price stability. The Monetary Council decided to adopt a number of measures to sterilise interbank liquidity, such as raising the reserve requirement ratio to 5 per cent and putting into effect once again

the legal consequences of non-compliance, activating the long-term liquidity-absorbing deposit¹⁶ and including it in the scope of eligible collateral, activating the QuickTender, and phasing out the one-week deposit and the preferential deposit.

In VIBER, the liquidity level of the payment system remained relatively stable in the first three quarters of 2022, at HUF 2,500 billion on average. However, by the end of September the account balances and intraday credit lines of VIBER participants began to rise substantially. The liquidity of the payment system exceeded HUF 7,500 billion by 10 October and remained at a level of HUF 6,000–7,000 billion until the end of 2022. Starting from October 2022, both the level of extended liquidity and the level of account balances – including short-term deposits – show a significant increase, with the former rising from HUF 3,000–4,000 billion to more than HUF 12,000 billion by early December (*Figure 13*).

The pronounced increase in the midnight account balance and liquidity can be attributed to the toolkit modification in October 2022. From 1 October 2022, the reserve requirement ratio was raised to a daily minimum of 5 per cent from the previous 1 per cent, and non-compliance with the requirement once again entailed legal consequences. As a result, the midnight VIBER balance of accounts rose from a range of HUF 150–590 billion to a peak of HUF 3,430 billion by 10 October (*Figures 11 and 12*).

Figure 11
Aggregated, midnight account balance and aggregated, midnight balance of the instant settlement account (AFR) of VIBER participants – 2022

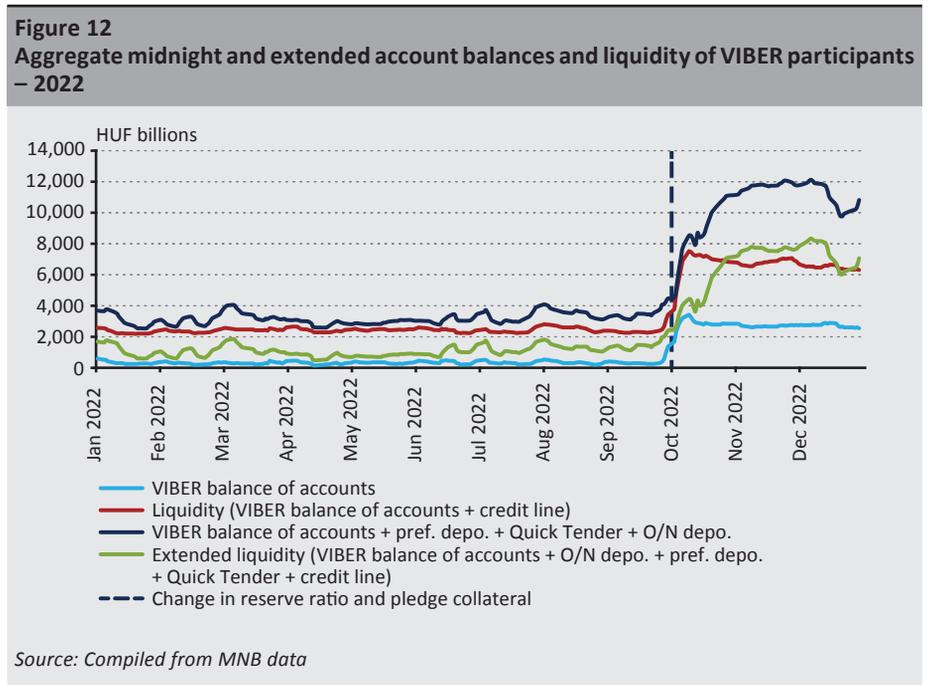


Note: Out of the HUF 688 billion account balance of the payment system on 1 January, HUF 547 billion is part of the VIBER balance of accounts, while HUF 141 billion is part of the instant settlement account balance.

Source: Compiled from MNB data

¹⁶ Floating-rate deposit facility with a maximum tenor of 6 months.

The level of the instant settlement account balance was affected, albeit moderately, by the changes in the central bank toolkit, but the magnitude of this change was far below that seen in the VIBER bank account balance. As a matter of practice, in order to comply with the reserve requirement ratio, system members keep their balances on their VIBER accounts rather than on their instant settlement accounts. Members can use the reserve requirement statement in the Instant Payment System (‘AFR’) to set, on a daily basis, which portion of their instant settlement account should be included in the reserve requirement. In the nine months preceding the toolkit change concerning the reserve requirement ratio (1 January 2022 to 30 September 2022), on average, members held 79 per cent of their reserve holdings on their VIBER accounts and 21 per cent on their instant settlement accounts, and in the three months following the toolkit change (1 October 2022 to 31 December 2022) the corresponding figures were 97 per cent and 3 per cent, respectively. Therefore, it can be said that the sterilised interbank liquidity resulting from the change in the reserve requirement ratio was mainly reflected in the balance of the VIBER accounts and only to a lesser extent in the balance of the instant settlement account balance.



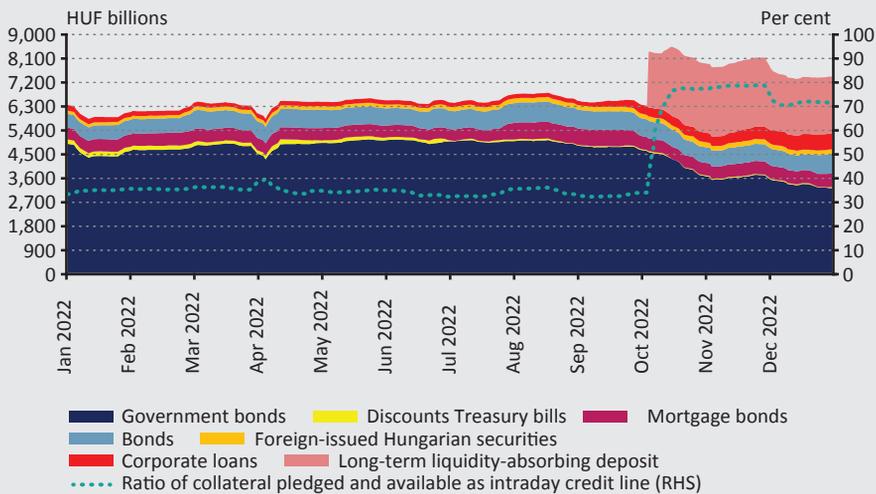
The change in the central bank toolkit did not have a significant impact on the correlation between the midnight account balances (account balance plus instant settlement account balance) and liquidity. While a strong correlation of 0.83 can be observed for the first nine months of 2022, the co-movement remained high for the remaining three months of the year, standing at a value of 0.77. This confirms that the modifications to the central bank toolkit adjusted both the account balance

and the instant settlement account balance, as well as the intraday credit line in the same direction (Figure 12).

The sharp increase in extended liquidity was partly due to the QuickTender activated on 14 October 2022, which amounted to more than HUF 4,000 billion at the end of October, mainly channelled through from the one-week deposit. Despite the significant changes in stock levels, the correlation between the account balances – including short-term deposits – and the extended liquidity did not change notably after October 2022, with a correlation of 0.97 for both the first 9 months and the last 3 months of the year (Figure 12).

The increase in the intraday credit line also played a role in the expansion of liquidity, which rose from HUF 2,000 billion at the beginning of the year to HUF 4,300 billion by mid-October. The composition of the pledged collateral behind the intraday credit line also changed in 2022. From October 2022, the floating-rate, long-term central bank deposit facility (liquidity-absorbing deposit) activated in order to sterilise interbank liquidity was also included as eligible collateral, thus contributing significantly to the increase in the intraday credit lines of VIBER participants and to the rise in payment liquidity. After the toolkit adjustment, the share of government bonds in the scope of eligible collateral declined gradually by 25 percentage points in 2022 Q4, the share of corporate loans increased sharply and accounted for more than 10 per cent of the collateral by the end of 2022, while the share of liquidity-absorbing deposits was close to 30 per cent (Figures 13 and 14).

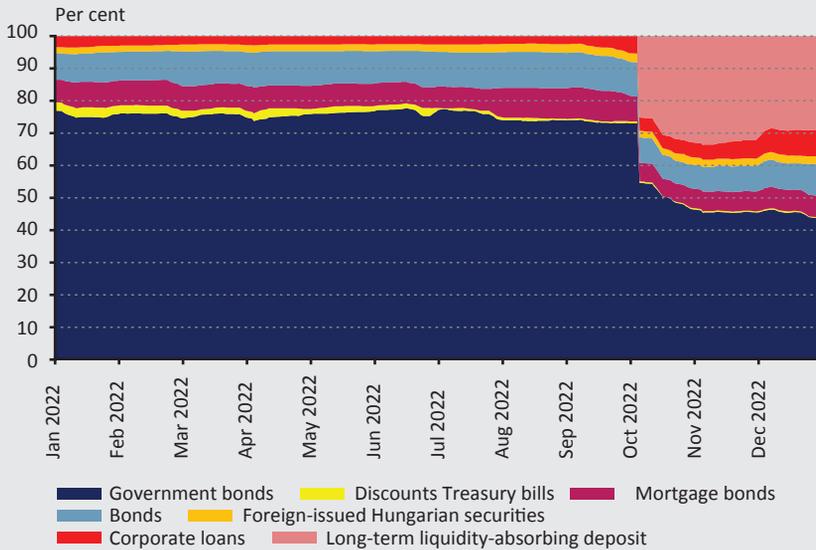
Figure 13
Ratio of pledged collateral to the intraday credit line – 2022



Note: For the ratio of intraday credit line: Ratio of credit line available for payments to the total portfolio of pledged collateral (excluding the collateral value of loans disbursed to SMEs under the FGS). 32.7 per cent of the HUF 6,304 billion pledged collateral on 1 January can be used for payment purposes.

Source: Compiled from MNB data

Figure 14
Breakdown of the composition of the pledged collateral portfolio – 2022



Source: Compiled from MNB data

Thanks to the toolkit adjustment, VIBER participants did not need to use their intraday credit lines at previous levels. Due to the raised reserve requirement ratio and the resulting rise in the balance of VIBER accounts, the MICL rate of VIBER participants with a higher level of liquidity declined to 1.2 per cent on average in the last three months of the year from 7.6 per cent on average in the first nine months of 2022, despite the fact that compared to the average turnover of the first nine months of the year, turnover rose by 31.8 per cent on average in the last three months of the year.

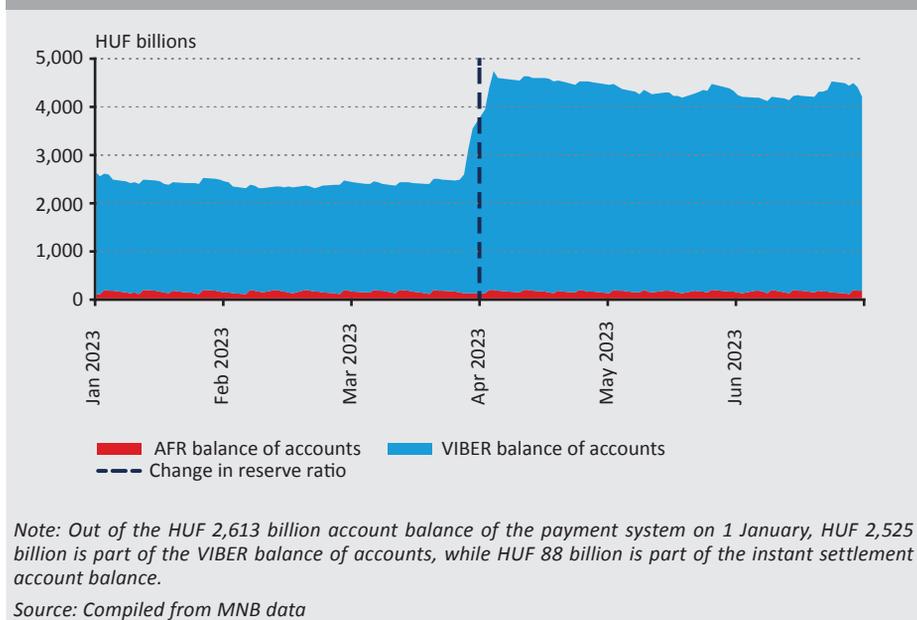
After September 2022, there were hardly any queuing transactions. After the reserve requirement ratio was raised to 5 per cent from 1 October, queuing fell by 66 per cent in the last three months of the year compared to the average for the first nine months of the year. The cases that did occur were also mainly due to a single participant's liquidity management deficiencies. Excluding the participant concerned, average monthly queuing decreased by 94 per cent after the toolkit adjustment from 1 October (1 October – 31 December 2022) compared to the first nine months of the year, which was not reflected in developments (a decline) in turnover.

3.4. 2023 H1

From a central bank perspective, in addition to achieving and maintaining price stability and reducing the impact of financial market turbulence, the primary objective in the first half of 2023 was to normalise the extraordinary interest environment introduced in October 2022, and with that in mind, the MNB implemented another series of toolkit adjustments. Besides cutting the key policy rate, the Monetary Council also decided to sterilise interbank liquidity by raising the reserve requirement ratio to a daily minimum of 10 per cent from 1 April.

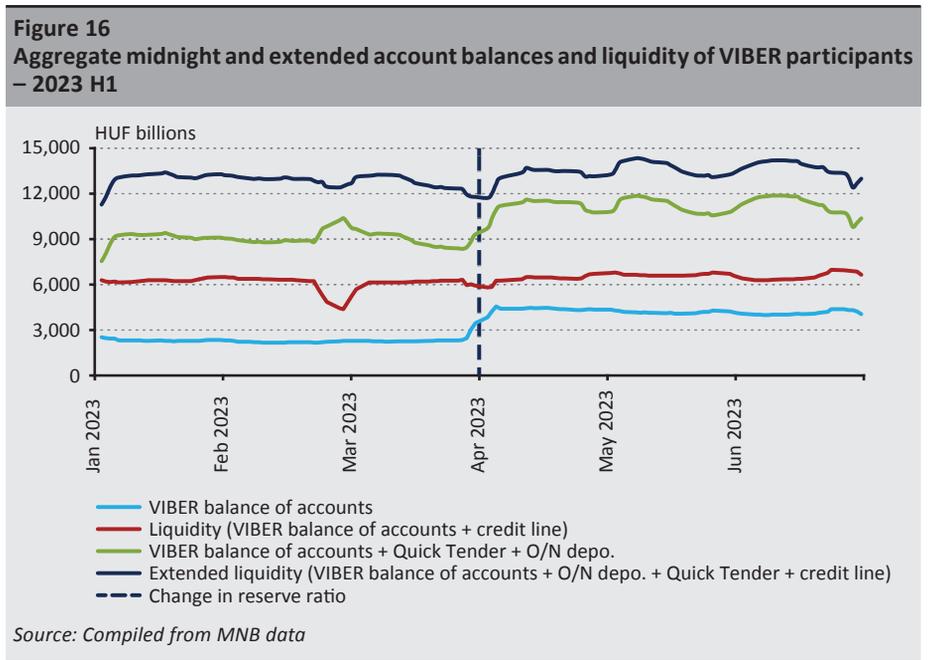
In VIBER, the liquidity level of the payment system remained relatively stable in the first half of 2023 and stood at HUF 6,300 billion on average, but the midnight balance of accounts rose substantially after 1 April 2023 as the reserve requirement ratio was raised to a daily minimum of 10 per cent. The midnight balance of VIBER accounts rose to HUF 4,200 billion from the average level of HUF 2,260 billion recorded before 1 April. For 2023 H1, both the level of extended liquidity and the level of account balances – including short-term deposits – show sharp fluctuations. Account balances – including the QuickTender and O/N deposits – soared to HUF 12,000 billion from the HUF 7,500 billion level recorded at the beginning of the year, while extended liquidity exceeded HUF 14,000 billion (Figure 16).

Figure 15
Aggregated, midnight account balance and aggregated, midnight balance of the instant settlement account (AFR) of VIBER participants – 2023 H1



The level of the instant settlement account balance was not significantly affected by the modifications to the central bank toolkit; the instant settlement account balance was HUF 133 billion on average in 2023 Q1 and HUF 141 billion in 2023 Q2. As in 2022, the moderate change was due to the fact that system members keep their balances on their VIBER accounts rather than on their instant settlement accounts as a matter of practice, in order to comply with the reserve requirement ratio (Figure 15).

The change in the central bank toolkit strengthened the correlation between the midnight account balances (account balance plus instant settlement account balance) and payment liquidity, albeit not significantly, with a correlation of -0.007 in 2023 Q1 and 0.26 in 2023 Q2. This change is mainly due to the fact that, while the level of liquidity-absorbing deposits in the pledged collateral making up the intraday credit line showed a high degree of fluctuation at the end of February 2023, the second quarter of the year was characterised by a lower but more stable level. However, the correlation between account balances – including short-term deposits – and extended liquidity changed significantly following the central bank toolkit modifications. While a correlation of 0.45 was observed in 2023 Q1, a strong correlation of 0.9 was seen in Q2 as a result of a decline in the intraday credit line (and thus its share in extended liquidity), while both the value of VIBER’s overnight account balances and the value of QuickTenders increased in Q2 (Figure 16).



The stagnation of liquidity was driven by a decline in the intraday credit line and an increase in the midnight balance; the former fell to HUF 2,600 billion at the end of Q2 from HUF 3,700 billion at the beginning of the year. The composition of the pledged collateral behind the intraday credit line also changed in 2023 H1. The portfolio of the floating-rate, long-term central bank deposit facility (liquidity-absorbing deposit), activated in order to sterilise interbank liquidity, contracted significantly in H1: while it reached HUF 2,135 billion at the beginning of the year, it was down to HUF 616 million by the beginning of April and HUF 391 million by mid-June. As a result, the distribution of the pledged collateral behind the intraday credit line also changed significantly, with government bonds accounting for a share of over 50 per cent once again, while the share of liquidity-absorbing deposits dropped to less than 15 per cent by the end of H1 (Figures 17 and 18).

Figure 17
Ratio of pledged collateral to the intraday credit line – 2023 H1

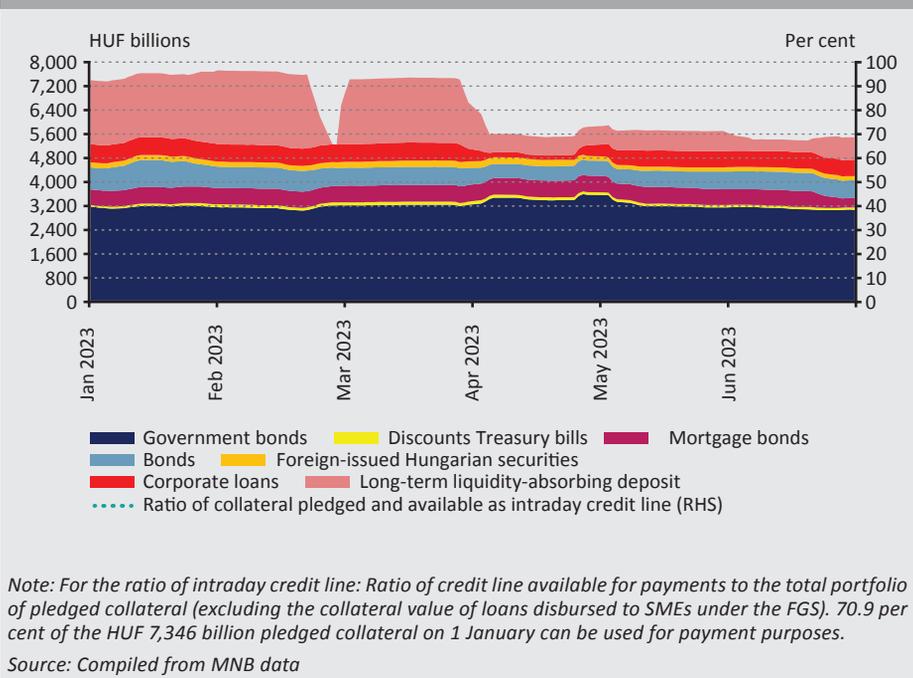
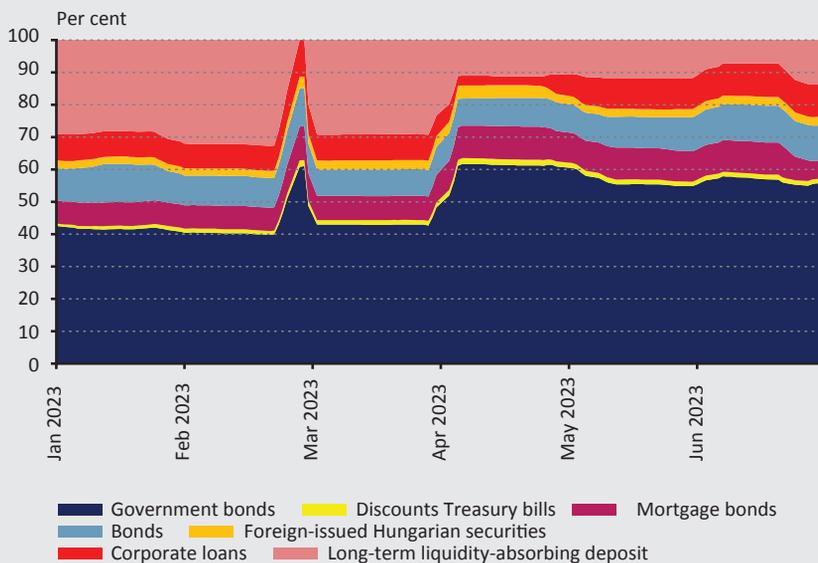


Figure 18
Breakdown of the composition of the pledged collateral portfolio – 2023 H1



Source: Compiled from MNB data

Thanks to the toolkit modifications, the maximum utilisation of the intraday credit lines of VIBER participants fell further from the low levels seen at the end of 2022. Owing to the raised reserve requirement ratio as of 1 April and the resulting increase in the VIBER account balance, the MICL value of VIBER participants decreased to 0.60 per cent on average in 2023 Q2 from 0.87 per cent on average in 2023 Q1, despite no significant change in turnover during Q1 and Q2, as turnover of HUF 15,150 billion per day was recorded on average in both quarters.

After September 2022, queues were almost non-existent; however, this trend was broken in 2023 H1, mainly owing to three VIBER participants as they accounted for almost 80 per cent of all queuing transactions. The reserve requirement ratio, which was raised to a daily level of 10 per cent from 1 April, failed to reduce queuing significantly. Excluding outliers, data indicate that the number of queuing transactions is below 30 per month with no significant change since April; consequently, we assume that the occasional queues are more likely to reflect inappropriate liquidity planning by the participants concerned, rather than a general lack of liquidity.

4. Summary

In order to ensure financial stability and the smooth functioning of payment and settlement systems, the MNB has at its disposal a wide range of instruments with diverging effects. Since each element of the central bank toolkit has its own role, the impact of individual modifications on the payment system, including the liquidity of the payment system, will obviously vary. As mentioned in the abstract, the main purpose of central bank toolkit modifications is to ensure the achievement and maintenance of the Bank's primary objective of price stability, which is closely linked to the need to maintain an optimal level of interbank liquidity. By presenting a particularly turbulent period, this analysis sought to provide an insight into a number of changes in the central bank toolkit that exerted a significant impact on the liquidity of the payments system. Experience confirms that, subject to the relevant business conditions, changes concerning the reserve requirement ratio have a direct impact on the liquidity of the payment system, which was foreseeable as it is directly related to the account balance; nevertheless, the value of the reserve requirement ratio has changed only 10 times since the turn of the millennium until mid-2023. Other significant changes to the central bank toolkit with a direct impact may include measures to increase interbank liquidity and to nudge one-week deposit holdings to overnight deposit facilities, as well as changes to the scope of eligible collateral, as pledged collateral is linked directly to the intraday credit line.

Some toolkit adjustments had little or no impact on payment liquidity, such as the fixed-rate collateralised loan instrument introduced on 24 March 2020, which partly served to improve banks' funding structure, and partly stimulated investment in long-term fixed-rate instruments but in our assessment, the increased interbank liquidity generated by the toolkit change was not channelled into payment system liquidity directly. Similarly, the one-week deposit facility activated on 1 April 2020, bearing interest at the central bank base rate, was intended to sterilise interbank liquidity, but did not have a direct impact on the liquidity subject to our analysis. Since the inception of the Funding for Growth Scheme and the Bond Funding for Growth Scheme, a preferential deposit has been included as an integral part of the schemes to ensure the sterilisation of the interbank liquidity they generate. While the preferential deposit is not included in the scope of eligible collateral, the overnight nature of the instrument means that the funds deposited can be used by participants for payment transactions throughout a significant part of the settlement day.

The potential effects of any changes to the monetary policy toolkit should be analysed and assessed on a case-by-case basis in consideration of all circumstances, to ensure the continued reliable operation of the payment system. Based on the experience of the past few years, it is important to stress that even at liquidity levels significantly lower than those seen at the time of the analysis, payment transactions would be smoothly processed in the payment systems of Hungary; in other words, there is ample liquidity available to process electronic payments in the domestic economy.

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Impact of the 2022 Energy Crisis on the Importance of Energy Performance Certificates for the Real Estate Market*

Dalma Eszter Fekete  – Eszter Baranyai 

This study relies on a unique database covering different segments of the residential real estate market to investigate whether the value of energy performance certificates was affected by the energy crisis in 2022. Based on the relevant literature, the study uses the linear regression estimation method, in which the effect of interaction is examined using the difference-in-difference method. The study shows that energy performance certificates have a significant impact on the estimated market value of properties, both by individual category and in groups. While in 2022 Q2, before the residential energy price increase, an energy-inefficient property cost 12 per cent less on average compared to a property with an average energy rating, controlling for other factors, that difference increased to 20 per cent after the outbreak of the energy crisis. It may therefore be worthwhile for Hungary to consider taking measures to improve the energy efficiency of buildings as soon as possible.

Journal of Economic Literature (JEL) codes: O13, Q40, R30, R31

Keywords: housing market, energy crisis, sustainability, energy performance certificate

1. Introduction

*‘The world is on the brink of the worst energy crisis since the 1970s’
(Jason Bordoff, 2022)*

The quote above comes from energy policy expert Jason Bordoff, a professor at Columbia University. The ominous phrase was uttered in the context of the Russian-Ukrainian war that broke out in February 2022, when restrictions on energy in the context of the war led to a surge in energy prices and insecurity of energy supplies.

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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Europe has been particularly strongly affected by the energy crisis due to its heavy dependence on Russian energy imports. The energy crisis has brought the issues of sustainability and energy efficiency even more to the fore, which is also true for the real estate markets. Improving the energy efficiency of building stocks may make a significant contribution to the fight against global warming (*Baji et al. 2023*).

According to the business press, interest in energy-efficient properties in Hungary has recently increased.¹ In addition to higher utility costs, this is probably due to the fact that the majority of Hungarian properties are significantly below the level of modern energy-efficient properties in terms of energy efficiency (*Bereczki et al. 2022*). Based on energy performance certificates, the share of properties with at least a modern energy performance classification in the housing stock was only somewhat higher in 2021 than in 2016 (*Ritter 2022*). This discrepancy might also be linked to the higher share of newly-built properties within the certificates.

As tensions in the energy market are not transitory, there is added value in focusing on the period of the energy crisis. It may be useful for several reasons to map how the pricing of energy efficiency in the real estate market has changed and to what extent this factor is currently priced in. On the one hand, at the level of individuals, it helps homeowners to price their property, develop a property investment strategy and, perhaps most importantly, assess energy modernisation options. On the other hand, at a societal level, governments can take forward-looking measures to improve energy efficiency, thereby reducing the risk of energy dependence and helping to meet climate targets to fight global warming. The extent of change (over a short period of time) may also provide valuable information for behavioural economists, as well as real estate market and macro modellers.

The research question of the study is whether the energy crisis of 2022 has had an impact on the relationship between property value and energy performance certificates. A related hypothesis is that the importance of energy performance certificates in the real estate market has increased significantly since the energy crisis. In this study, the onset of the energy crisis is defined as the change in the regulation of utility costs in Hungary. The data for the research is provided by the mortgage data of a commercial bank in Hungary, which contains property valuation data for the year 2022. The linear regression methodology was used for the research, in which the effect of the interaction of the energy crisis and energy performance certificates is examined using the difference-in-difference method.

We demonstrate that since the beginning of the energy crisis there has been a statistically significant change in the value of energy performance certificates for energy-inefficient buildings. Before the rise in household energy prices, an energy-

¹ Forbes (19 April 2023). *Housing market: that's what good insulation means in terms of price*. <https://forbes.hu/penz/lakaspac-szigeteles-ingatlan-napelem/>. Downloaded: 7 February 2024.

inefficient property cost 12 per cent less on average compared to an average energy-efficiency property, controlling for other impacts, while this difference averaged 20 per cent in the third and fourth quarters of the year, after the onset of the energy crisis. As a combined effect, the value of HH–JJ category homes was nearly 1 per cent lower in the fourth quarter compared to the pre-energy crisis period (second quarter), despite the overall (nominal) house price increase observed during the period. Consistent with previous findings in the literature, for the sample as a whole,² we find that energy performance certificates have a significant explanatory power on property values: compared to average energy-efficiency buildings, energy-efficient homes cost 7 per cent more on average, while energy-inefficient properties cost 17 per cent less on average, other effects considered. Looking at individual energy performance certificate categories, almost all categories reflect a significant increase in the estimated market value of the property compared to the lowest-rated building; GG-certified properties are 12 per cent more expensive on average, while the highest AA–BB category properties are more than 35 per cent more expensive.

Thanks to the unique database, the study contributes to the literature in two ways: to the best of our knowledge, our work is the first scientific study in Hungary that examines changing preferences towards the energy consumption of properties, as reflected in real estate prices, in a period of energy uncertainty and energy price increases. Additionally, it enables more general conclusions concerning the residential real estate market, as the scope of our study is not limited to certain market segments.

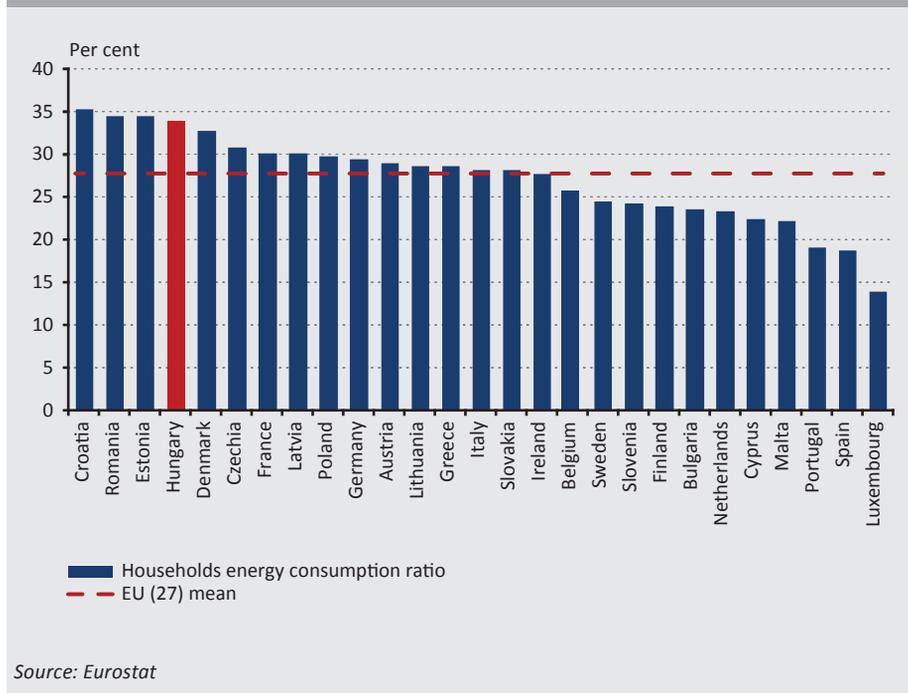
Section two of the paper puts the research question in the context of sustainability and energy efficiency, before discussing the regulation of energy performance certificates in Hungary, the current situation of the real estate market and the circumstances of the energy crisis in Hungary in 2022. *Section three* reviews the relevant literature on energy efficiency and house prices. *Section four* presents the data used in the study and their characteristics, followed by a description of the methodology. *Section six* describes the results of the research in detail, with a special focus on the interaction term of energy performance certificates and the energy crisis. This is followed by a statement of the limitations of the research. Finally, the summary outlines broader perspectives and draws conclusions.

² Including the months before and after the energy crisis began.

2. Sustainability and energy efficiency in the real estate market

The issue of sustainability and global warming has undoubtedly become one of the most discussed topics. As the energy consumption of buildings plays a significant role in sustainability, one important question is what can be done to reduce that need (*Da Cunha – De Aguiar 2020*). The severity of the problem is underlined by the fact that in 2021 residential energy use in Hungary accounted for 34 per cent of total energy use,³ due to buildings that mostly rely on the use of obsolete types of energy. As *Figure 1* shows, this is the fourth highest figure in the European Union and is significantly higher than the EU average of 27 per cent.⁴

Figure 1
Use of residential energy in EU countries as a percentage of total energy consumption



³ Source: Hungarian Central Statistical Office (HCSO): *Final energy consumption by sector*. https://www.ksh.hu/stadat_files/ene/hu/ene0006.html. Downloaded: 20 March 2023.

⁴ Source: Eurostat: *Final energy consumption by sector*. https://ec.europa.eu/eurostat/databrowser/view/ten00124__custom_7920493/bookmark/table?lang=en&bookmarkId=1a5f18a1-7dbe-4565-8602-a21cc3849f7f. Downloaded: 14 October 2023.

The energy efficiency of a building is influenced by a number of factors, which, according to *Chen et al. (2020)*, can be divided into three broad categories: (1) the insulation and quality of windows and doors; (2) the cooling and heating systems of the building, the proportion of energy-efficient lighting and appliances and related intelligent control systems; and (3) the location of the property and local weather conditions, which have recently started to receive more attention in economics literature.⁵ Use of the term ‘energy-efficient building’ (*Khosla – Singh 2014*) is becoming increasingly widespread, referring to buildings that help reduce the rate of global warming by using energy and water more efficiently and encourage the use of renewable energy sources. In the future, two key factors will thus dominate the real estate markets: reducing the environmental impact of buildings, and reducing the energy demand of buildings when constructing new properties or renovating existing ones (*Ionescu et al. 2015*).

2.1. The concept of energy performance certificates

In order to measure the energy efficiency of individual buildings, an increasing number of countries require an energy performance certificate. This has been a legal requirement in Hungary since 2012 for new buildings and for the sale of existing buildings.⁶ This means that not all properties are certified yet, but as time goes by, more and more buildings will be subject to an energy analysis. The scale of the certificate varies from country to country. Between 2016 and 2023 a 12-step scale was applied in Hungary, with AA++ and JJ as the best and the worst rating, respectively (*Takarék Index 2022*).⁷ In 2022, 20 per cent of properties were covered by certificates based on the 12-degree scale (*Bereczki et al. 2022*); however, they were unevenly distributed throughout the country. For example, in 2020, when the national coverage was 15 per cent, this share was 9 per cent in the municipalities of Southern Great Plain and 19 per cent in the towns of Pest County (*Bene et al. 2023*).

An explanation of each category is summarised in *Table 1*. The 12-grade scale can be divided into 3 major groups: the designations AA++, AA+, AA, BB and CC refer to the highest-rated energy-efficient properties, with AA–BB homes having at least 25 per cent renewable energy demand. The EU Taxonomy requires a near-zero energy demand for energy-efficient properties, and this requirement is not satisfied by CC-rated homes; however, since the CC rating has been the requirement for new-built properties for a long time and there are comparatively few AA–BB category properties in our sample, we include the CC category in the sufficiently efficient

⁵ *Baranyai – Banai (2022)* is relevant for the relationship between the location of the property and weather conditions. Point 3) appears in few economics studies, and this focus is novel from an economics point of view.

⁶ Government Decree No. 176/2008 (VI. 30.) on the certification of the energy performance of buildings

⁷ While it was replaced by a new certification scheme in November 2023, the study uses 2022 data to examine the previous certification system.

group. Properties labelled as DD, EE, FF and GG have an energy rating around the average, while HH, II, JJ are considered energy-inefficient homes (Horváth et al. 2013; Ramos et al. 2015). Measurements for energy performance certificates are carried out by professional companies established for this purpose and the measurement result remains valid for 10 years from the date of issue (Ertl et al. 2021).

Table 1
Categories of energy performance certificates in effect since 2016 and their explanation

Energy-efficient properties	AA++	<40%	Minimum energy demand
	AA+	40–60%	Outstanding energy efficiency
	AA	61–80%	Better than near-zero energy demand
	BB	81–100%	Near-zero energy demand
	CC	101–130%	Modern
Buildings with average energy use	DD	131–160%	Close to modern
	EE	161–200%	Better than average
	FF	201–250%	Average
	GG	251–310%	Close to average
Energy-inefficient homes	HH	311–400%	Weak
	II	401–500%	Poor
	JJ	>500%	Very poor

Note: The third column shows the value of the aggregated energy performance as a percentage of the prescribed energy performance requirements in the legislation. For newly-built properties, this value can be up to 76 kWh/m², which corresponds to a near-zero energy building.

2.2. Characteristics of the property market in Hungary

Hungary has one of the highest levels of residential energy use within the EU (Koltai et al. 2021:10), as the vast majority of Hungarian buildings are outdated from an energy point of view. This means that rising energy costs are a key problem. The energy efficiency of a property is strongly influenced by the year it was built and whether it has undergone any major renovation in recent years. The latter is of particular importance as Hungary has an extremely high number of buildings built before the political transition (65 per cent of the total housing stock was built before 1981),⁸ and those buildings are now considered outdated (Takarék Index 2022). Homes with inefficient energy use not only have a negative impact on the

⁸ Source: HCSO: Rooms in homes by country district. <https://nepszamlalas2022.ksh.hu/adatbazis/#/table/WBL006/N41gFgpgghgJiBcBtEAVAgWQKIHOAKWASmgPIAilAugDQgDOAljBASlgQGr4kDCAjFVpOIAyWAuDA-PYA7VjRAAZBgBsxEAE50EoANYNpceCAxQADiFoRy9QwhakIAL5OgA=>. Downloaded: 7 February 2024.

environment, they also have significantly higher utility costs. According to *Koltai et al. (2021)*, in 2010, almost half of all Hungarian households considered paying utility bills as a burden, while 7 per cent of the population faced the problem of energy poverty, i.e. a building with energy costs twice the median (*Koltai et al. 2021:14*). The Hungarian government and the MNB have put into place several forms of support to increase the energy efficiency of the housing stock, such as the Green Home Programme, the Home Renovation Programme, which can also be used to improve energy efficiency, the low-interest home renovation loan and the Green Mortgage Certificate (*Takarék Index 2022; Kandrács 2023; Nagy et al. 2021*).

2.3. The role of the energy crisis caused by the Russian-Ukrainian war

The Russian-Ukrainian war that started on 24 February 2022 has had numerous negative economic consequences. This is particularly true for the European Union, given its dependence on Russian energy imports, as energy prices in the region increased dramatically (*Csáki 2021*) before starting to decline. The 2022 energy crisis has thus highlighted the need for a new, more sustainable energy policy in European countries, as the unaffordable cost of gas and electricity poses a problem for the population (*Tóth et al. 2023*). In Hungary, a law on reducing utility costs was introduced in 2013⁹ to reduce energy prices that had increased in the wake of the 2008 global economic crisis; it provided for a price cap on the universal retail prices of gas and electricity. This meant that even in the months after the war started, Hungarian citizens paid a fixed price for the energy they used, regardless of the market environment. However, the sudden price increases triggered by the Russian-Ukrainian war made the law on reducing utility costs unsustainable. Consequently, in July 2022, the law was amended. Since 1 August 2022, retail customers have been charged a higher fixed price for the portion of the annual average electricity and gas consumption in excess of the average consumption of 2,523 kWh for electricity and 1,728 m³ for natural gas.¹⁰ As a result, the Hungarian population was exposed to the effects of the energy crisis with a delay. However, this does not mean that the problem has been less severe than in other countries, partly because of the characteristics of an outdated housing stock (*Subsection 2.2*). *'The renewal of the housing stock, while achieving climate goals, may also improve resilience to a potentially prolonged energy crisis'* (*Takarék Index 2022:6*), as the majority of the Hungarian housing market is made up of properties built before the end of communism, and 80 per cent of households consuming more than 120 per cent of average household energy consumption are linked to such properties (*Tóth et al. 2023:134*). In such an environment, buyers may become more sensitive to the energy characteristics of properties, as confirmed by the MNB's estimated price index on residential mortgage transactions (*MNB 2023*). Interestingly, the price

⁹ Act LIV of 2013 implementing the reductions in utility bills.

¹⁰ Government Decree No. 259/2022. (VII. 21.) determining certain universal service tariffs.

index shows that the highest increase in the gap between i) residential properties solely relying on reduced-price energy, and ii) gas-heated residential properties with energy consumption above the reduced-price threshold occurred in 2022 Q4. The price index of the latter group fell by 1.3 per cent during the quarter, while the price index of the former rose by 1.2 per cent during the same period. Among the possible reasons for the delayed effect, the MNB suggests that sellers were only willing to reduce prices over time and as a result of reduced market liquidity.

3. Factors affecting house prices

Trends in the real estate market and the factors that influence real estate prices have long been the subject of research. The literature suggests that, in addition to macroeconomic factors, the individual characteristics of a property also have a major impact on its market value. Among other things, these include property characteristics (1), such as floor area and lot size, the number of rooms (*Lu et al. 2017*), the year of construction, type of house (detached, prefab, semi-detached, etc.), its comfort level (*Zietz et al. 2008*), and property amenities, such as a garage, basement and attic (*Herath – Maier 2010*). They also include the location of the property (2), such as its distance from town centres, schools and transport hubs (*Chow 2011*), potential environmental hazards, noise and air pollution (*Allen et al. 2015*), and energy characteristics (3), such as the characteristics of the cooling and heating system (*Ramos et al. 2015*). Recently, there has been an increasing focus on the relationship of house prices with the labour market (*Békés – Bisztray 2020*), regional differences (*Székely 2000; Banai et al. 2018*) and energy efficiency (*Ertl et al. 2021; Hajnal et al. 2022; Horváth et al. 2013*) in Hungary. The literature on the latter is summarised in the following subsection.

3.1. The relationship between energy performance certificates and house prices

The relationship between energy performance certificates and house prices has been studied in several countries, including Hungary. A summary of the results is shown in *Table 2*. The scaling and calculation methodology of energy performance certificates may differ between countries, making comparisons difficult (*Ertl et al. 2021*). Overall, the literature suggests that in most of the countries and periods studied higher energy ratings/better energy efficiency are reflected in higher house prices. Several factors may underlie the spatial variation in the impact of energy efficiency on house prices, such as the country's weather, the energy-efficiency characteristics of the housing stock, the temperature preferences of the population, climate awareness, etc. A detailed exploration of these factors, however, goes beyond the scope of this study.

In Germany, *Taruttis and Weber (2022)* investigated the relationship between energy efficiency and the sales value of properties between 2014 and 2018, using a sample of more than 400,000 observations; they found that a 100 kWh/m² reduction in specific energy demand leads to an average increase in real estate prices of 6.9 per cent. In terms of the Hungarian scale, this is roughly equivalent to the difference between the energy-inefficient and energy-efficient home groups relative to the average energy-efficiency group. *Hahn et al. (2018)* showed that the heating system has a significant explanatory power on the purchase price and rent of buildings, as 'green' systems are more overvalued than 'brown' systems that use fossil energy. In Ireland, *Stanley et al. (2016)*, controlling for the year of construction and the type, size and location of properties, found that a 50 kWh/m² lower specific energy demand is associated with a 1.5 per cent higher market price, while a value 1 point higher on a 15-point energy performance certificate scale from G to A1 equals a 1 per cent higher property price.

Ramos et al. (2015) analysed the Portuguese real estate market in their research, measuring the role of energy performance certificates in relation to the D rating. Based on their results, the price of A-, B- and C-certified buildings is 6 per cent higher on average than that of D-certified houses. Properties with poorer energy efficiency (E, F or G) imply a 4 per cent lower price compared to average energy-efficiency buildings, which means that people are willing to pay a higher price for a better energy rated property. A study based on over 190,000 data points from the Welsh housing market (*Fuerst et al. 2016*) shows that prices for A and B category properties are 11 per cent higher than for houses with a D category energy performance certificate, while prices for C category properties are 2 per cent higher. Compared to the D label, the E, F and G labels are 2 per cent, 5 per cent and 7 per cent cheaper, respectively. Factors influencing Spanish property prices have been studied by, among others, *Marmolejo-Duarte – Chen (2022)*, who found that when controlling for building quality and location parameters, a one-step higher energy performance certificate category corresponds to a 2 per cent higher price.

For the Norwegian housing market, there is no consensus in the literature on the price impact of energy efficiency. First, according to *Khazal – Sønstebo (2020)*, for properties surveyed between 2010 and 2018, green-labelled buildings (A, B and C) offer a 6 per cent premium over buildings without an energy performance certificate, and an average price that is 6 per cent higher for an A energy-efficient building compared to the worst (G) category. On the other hand, according to *Olaussen et al. (2019)*, energy efficiency or energy performance certificates do not play a significant role in the evolution of house prices. The quantitative result was supported by a questionnaire survey, which showed that buyers are not willing to pay a higher price for a building with better energy efficiency, as opposed to a better

location, larger size or more rooms. Also in the Netherlands, *Murphy (2014)* found that there is only a weak relationship between energy performance certificates and house prices; similarly, observing the Italian real estate market, *Fragonard et al. (2017)* also found that there is no significant effect of energy performance certificates on house prices when controlling for the basic characteristics of the property.

In Hungary, three major studies have been carried out on this topic. The first of these, by *Horváth et al. (2013)*, investigated the impact of energy renovation projects between 2004 and 2009: their results show that such renovations had a positive impact of 9.81 per cent on prices. *Ertl et al. (2021)* investigated the detached house segment and found that, controlling for location and building characteristics, houses with more modern energy use or houses that have undergone energy renovation feature a significant price premium. Buildings in categories AA–BB have significant explanatory power compared to all other categories. The most recent research on the newly-built housing project segment found that in Budapest, new-build houses with AA–BB energy performance certificate cost 5.1 per cent more on average than houses with a CC energy performance certificate (*Hajnal et al. 2022*).

Compared to the two articles on Hungarian data published in the past few years, our study covers a wider range of properties, i.e. not only detached houses or new-build properties in our unique database. By analysing the data, therefore, more general conclusions may be drawn. The other main contribution of the study is that it offers a unique way of looking at the energy crisis, which allows us to document changing preferences and relationships reflected in house prices.

Table 2			
Summary of the literature to date			
Country	Period under review	Author(s)	Result
Germany	2014–2018	<i>Taruttis – Weber (2022)</i>	A significant positive relationship exists between energy efficiency and house prices
	2015	<i>Hahn et al. (2018)</i>	Heating system has significant explanatory power for house prices
Ireland	2009–2014	<i>Stanley et al. (2016)</i>	A significant positive relationship exists between energy efficiency and house prices
Portugal	2015	<i>Ramos et al. (2015)</i>	A significant positive relationship exists between energy efficiency and house prices
Norway	2000–2014	<i>Olaussen et al. (2019)</i>	Energy demand and energy performance certificates have no significant impact on prices
	2011–2018	<i>Khazal – Sønstebø (2020)</i>	A significant positive relationship exists between energy efficiency and house prices
Netherlands	2013	<i>Murphy (2014)</i>	Energy performance certificates have only a moderate impact on house prices
United Kingdom	2003–2014	<i>Fuerst et al. (2016)</i>	A significant positive relationship exists between energy efficiency and house prices
Spain	2020	<i>Marmolejo-Duarte – Chen (2022)</i>	A significant positive relationship exists between energy efficiency and house prices
Italy	2011–2014	<i>Fregonara et al. (2017)</i>	Energy performance certificates have no significant impact on house prices
Hungary	2020	<i>Ertl et al. (2021)</i>	A significant positive relationship exists between energy efficiency and house prices
	2019–2021	<i>Hajnal et al. (2022)</i>	A significant positive relationship exists between energy efficiency and house prices
	2004–2009	<i>Horváth et al. (2013)</i>	Energy renovation significantly increases the value of the property

Note: Dark green indicates a strong positive relationship between energy efficiency and housing prices, light green shows a weak relationship and grey denotes no significant relationship.

While the data include all 12 categories of energy performance certificates used in Hungary since 2016, the number of buildings with AA++, AA+ and AA ratings is significantly lower than the other categories. Therefore, for ease of presentation, these categories are presented in aggregate. As the energy performance certificate is based on the amount and efficiency of energy use, it is worth checking the consistency of the data for reliability purposes.

The x-axis in *Figure 3* shows the primary energy use of the properties in the sample, which measures the energy use per square metre on an annual basis. The figure shows that the category of energy performance certificates neatly corresponds to the extent of primary energy use, with the majority of buildings with almost zero energy demand having the highest energy performance certificate, while those using more than 300 kWh of energy per year are assigned the worst classification – HH, II or JJ. As data on energy performance certificates normally become available through transactions and many have difficulty in interpreting a value in kWh/m²/year, our analysis looks at the energy performance certificate categories rather than the value of the energy consumption of the property. Regarding the relationship between primary energy use and the price per square metre of the property, *Figure 4* shows that in accordance with our previous expectations properties with better energy efficiency and thus higher ratings are worth more on average than those with lower energy efficiency. The relationship between the two variables is illustrated by the dashed trend line in the figure, which shows a decreasing trend towards lower energy-efficient properties. The relationship between the energy performance certificate and the market price is examined formally later in the paper.

In 2022, 135,362 energy performance certificates were issued for properties in Hungary, according to the national electronic register of energy performance certificates.¹² Their distribution is presented in *Table 3*, which shows that nearly 30 per cent of the data belong to the best performance group (AA–BB and CC) in the study, 41 per cent of the data belong to the average category (DD–GG), and 29 per cent of the data belong to the worst performance group (HH–JJ). Examining the sample data, 37 per cent of the homes are in the highest energy-efficiency category (AA–CC), 44 per cent are in the average energy-efficiency category (DD–GG) and 19 per cent are in the energy-inefficient category (HH–JJ). The most frequent category in the sample and in the actual data is CC. The discrepancy in the distribution of the sample certificate data may be due to the higher share of properties built after 2010, which increases the number of AA–BB certificates.

¹² Source: https://entan.e-epites.hu/?stat_megoszlas

Figure 3
Relationship between specific energy demand and energy performance certificates

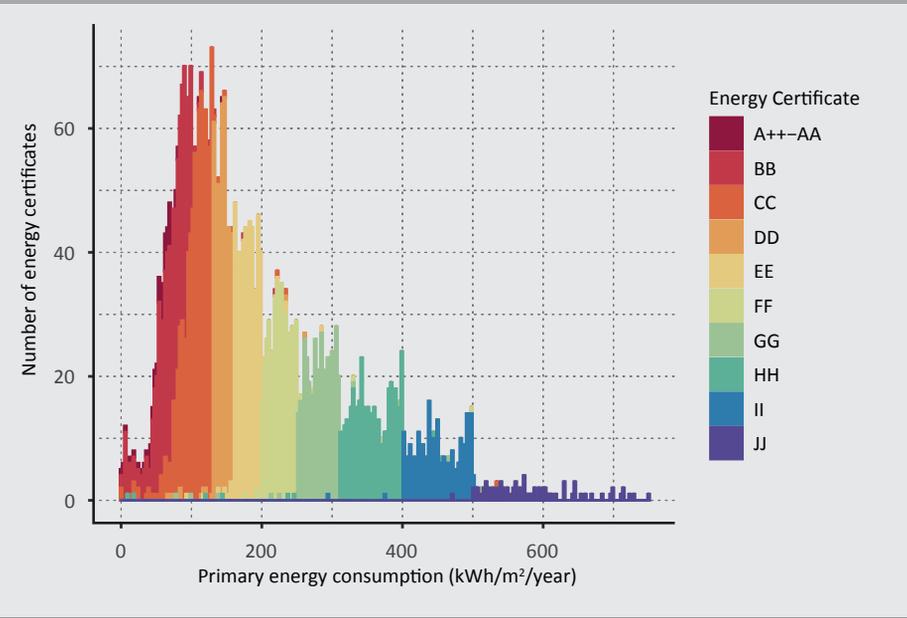


Figure 4
Relationship between energy performance certificates and estimated price per square metre

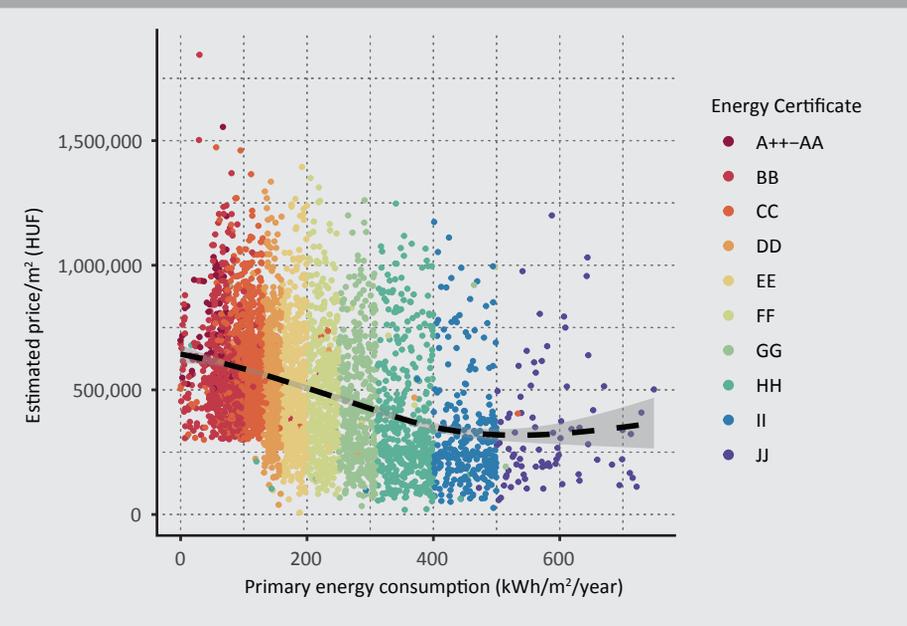


Table 3**Distribution of certificates issued in 2022 compared to the sample**

	Actual distribution (%)	Sample distribution (%)
AA–BB	12.7	16.40
CC	16.6	20.32
DD	9.7	11.70
EE	10.3	12.60
FF	10.7	10.60
GG	10.7	9.60
HH	13.6	10.10
II	10.2	6.50
JJ	5.4	2.20

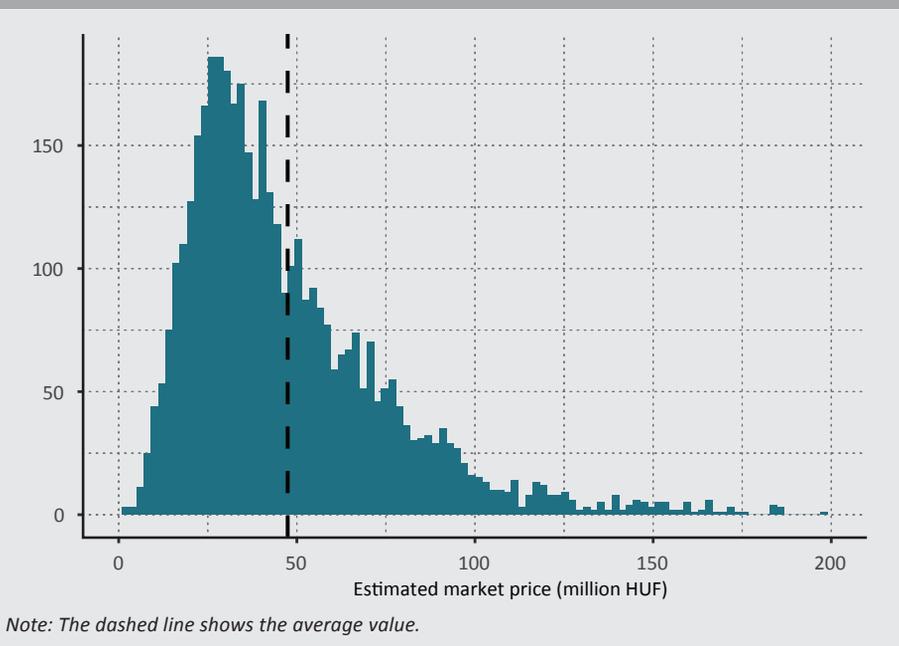
5. Methodology

The study uses the linear regression estimation methodology, which is often employed in the literature to investigate the relationship between house prices and energy performance certificates (Ertl et al. 2021; Hajnal et al. 2022; Ramos et al. 2015; Stanley et al. 2016; Taruttis – Weber 2022). In the regression model, we use a difference-in-difference estimation method to examine the effect of the energy crisis, as this methodology is suitable for estimating an impact based on changes over time (Ramos et al. 2015). The dependent variable of the model is the estimated market value of dwellings, while the explanatory variables include the energy performance certificate, the quarters of years and their interaction with the energy performance certificate and the control variables. The regression equation is as follows:

$$\begin{aligned}
 Y^* = & \beta_0 + \beta_1 \text{energy performance certificate} + \beta_2 Q1 + \beta_3 Q3 + \beta_4 Q4 \\
 & + \beta_5 Q3 \times \text{energy performance certificate} \\
 & + \beta_6 Q4 \times \text{energy performance certificate} + \text{control variables} + \varepsilon,
 \end{aligned} \tag{1}$$

where β_0 is a constant representing the intersection of the regression line and the y-axis; β_1 is the coefficient of the energy performance certificate; β_2 is the coefficient of the first quarter; β_3 is the coefficient of the third quarter; β_4 is the coefficient of the fourth quarter; β_5 is the effect of the third quarter on the relationship between the energy performance certificate and house prices; β_6 is the effect of the fourth quarter on the relationship between the energy performance certificate and house prices; and ε stands for the error term. Based on the difference-in-difference method, the energy performance certificate multiplied by the quarters (Q3–Q4) shows how the price of buildings with a higher (AA–CC) or lower (HH–JJ) energy performance certificate changed during the quarter relative to buildings in the average energy performance category (DD–GG). In the interaction model, we compare to the second quarter of the year.

Figure 5
Histogram of the dependent variable of the model



The dependent variable in the regression is the market value of the property, as estimated by the appraisers (Y^*), which is a noisy transformation of the actual price (Y).¹³ Suppose $Y=Y^*+v$, where v is a normally distributed error term with the expected value 0. In this case, the regression coefficients β in the equation (1) will not be biased; however, the variance of the (composite) error term ($\varepsilon+v$) is larger than in a regression where the real price (Y) is the dependent variable.

The histogram of estimated market values is shown in *Figure 5*. The distribution of the variable is skewed left and elongated right, with a minimum value of HUF 600,000, a maximum value of HUF 401 million and a mean of HUF 48.5 million. It is presented in logarithmic form in the model for ease of interpretation. The explanatory variables of the estimate can be grouped into three categories. The explanatory variable considered in the model is the energy performance certificate, which is broken down into the three groups mentioned earlier: energy-efficient properties (AA–CC), average energy-efficiency properties (DD–GG) and energy-inefficient properties (II–JJ). The average efficiency category is the control group in the study. The additional control variables can be split into housing characteristics and variables focusing on geographical location. The continuous control variables are logarithmic in the model as in *Ramos et al. (2015)* and *Taruttis – Weber (2022)*,

¹³ Exact transaction data were not available. Mortgage lending is based on the appraisal process, which determines the size of the loan.

similarly to the dependent variable, while the year of construction is divided into five categories: 1880–1940, 1941–1980, 1981–2000, 2001–2010, and after 2010.

The comfort level is a three-degree scale, ranging from no comfort to full comfort, with 80 per cent of data falling into the latter category. Properties are broken down by type into two groups, i.e. detached houses and flats, which are represented in the sample roughly equally. The reason why we use the third and fourth quarter dummy variables in the interaction terms is that these are the time periods after the partial phase-out of the cuts in utility costs in Hungary. As the measure was announced by the government on 13 July 2022, just over two weeks before it was due to enter into force (*Government of Hungary 2022*), we do not expect a significant impact on prices before July.¹⁴

6. Descriptive regressions

This study examines whether the importance of energy performance certificates has increased in house prices since the start of the energy crisis in 2022. Before answering the research question, the paper builds a linear regression model to explain house prices and examines whether there is a relationship between energy efficiency and house prices over the sample period as a whole. It may indicate a problem with the data or the model if the results found are at odds with the literature or intuition. Two models are employed, which differ in that the first one uses certificates as individual categories, while the second one groups them together. Both models thus contain 4,400 observations and are considered significant by the global F-test. Based on the coefficient of determination, the first model explains 75 per cent of the variance of the dependent variable, while the second explains 74 per cent. In both models, the dependent variable is the logarithmic form of the estimated market value of the property, explained by 8 control variables in addition to the energy performance certificate, almost all of which are significant. The results are summarised in *Table 4*.

In the model, the effect of the explanatory variables is interpreted *ceteris paribus*, i.e. with all other variables held constant. For energy performance certificates, the worst (JJ) rating in the first model was used as the control group. *Figure 6* clearly shows that by including the individual categories of certificates, we can see a progressively higher property price from the worst category to AA–BB classification. All ratings apart from the bottom two categories (II, HH) were significant, with GG-certified properties costing 12 per cent more, FF buildings 21 per cent more and EE groups 23 per cent more on average compared to the worst-rated buildings. The DD category indicates a 25 per cent higher average price, the CC category 29 per cent higher, while AA–BB properties cost 35 per cent more on the property market compared to the JJ category. Looking at the difference between the adjacent

¹⁴ We only have information for the month of the valuations.

categories, there are three places where a significant difference is observed: one level up from the HH mark, there is a 6 per cent difference in property prices; one level up from the FF mark, there is a 9 per cent difference on average, and there is a significant 7 per cent difference between the CC and AA–BB categories.

In the second model, the difference (compared to the first model) was due to the fact that the energy performance certificate categories were divided into three groups, with average energy-efficiency properties constituting the control group. Again, significant differences between groups were found, as illustrated in *Figure 7*. Compared to medium-rated (DD–GG) homes, energy-efficient home prices are 7 per cent higher on average and energy-inefficient homes are 17 per cent less expensive on average.

The results for the impact of energy performance certificates are consistent with other literature on the Hungarian housing market. *Hajnal et al. (2022)* found a 5 per cent price premium for energy-efficient properties compared to average-rated properties. Looking at individual energy performance certificate categories, *Ertl et al. (2023)* found that homes in the FF group are sold for a 20 per cent higher price compared to the worst-rated properties, while the best-rated category can have a premium of up to 52 per cent. This suggests that the issue of energy efficiency has not only become an important topic in public life, but also appears in the pricing of real estate, and thus it is worth considering these features when buying or renovating a home.

Figure 6
Estimated impact of energy performance certificates on house prices (individual values)

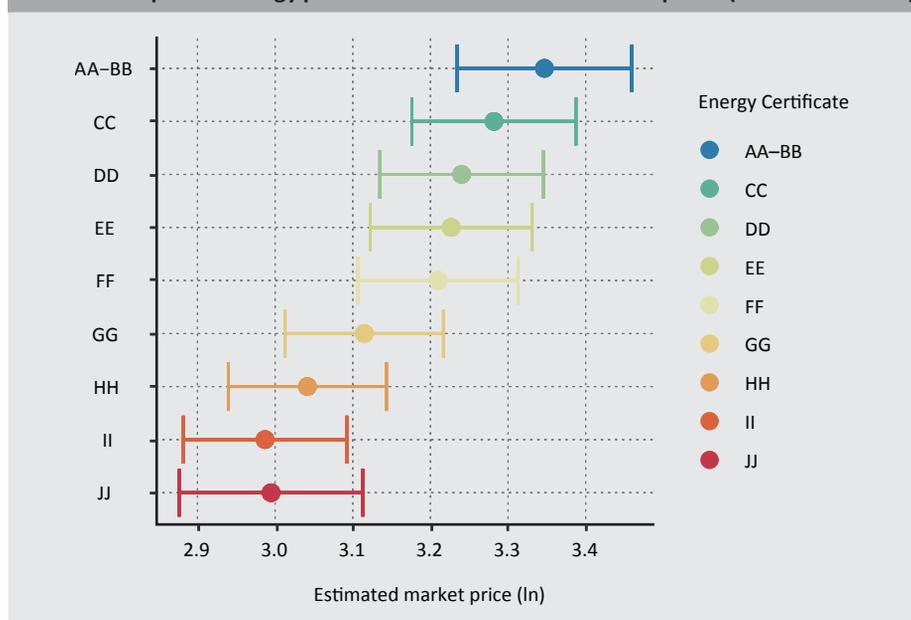
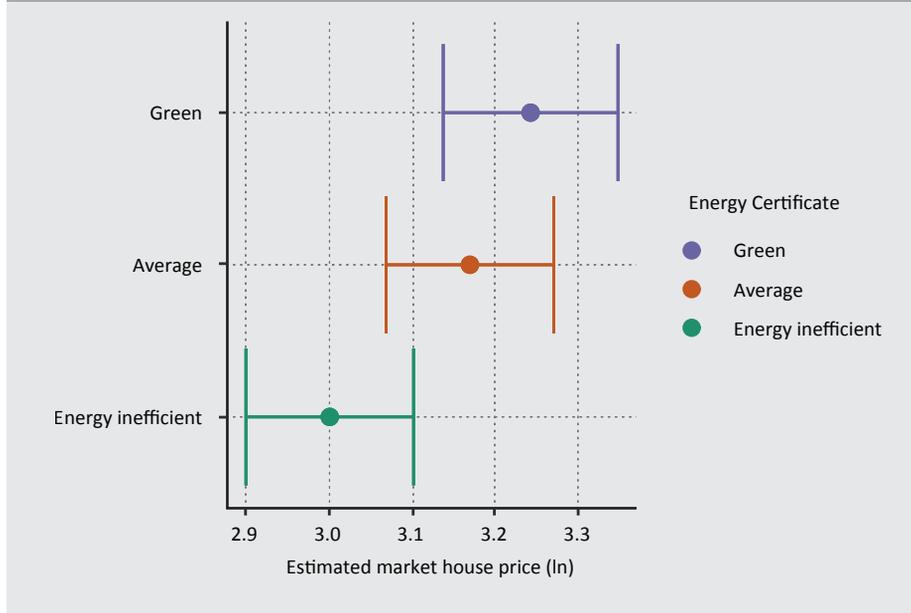


Figure 7
Estimated impact of energy performance certificates on house prices (grouped)



Most of the control variables were significant at a 5 per cent p-value, except for the distance from the town centre and the property type in the first model. In line with preliminary expectations, larger floor areas and a higher population (in the settlement) are associated with higher market values, while the estimated market value of a flat is 4 per cent lower on average than that of a detached house. Comparing buildings in terms of comfort level, it can be seen that, compared to houses without amenities, a full comfort level may amount to a property price up to 15–17 per cent higher. In terms of the year of construction, houses built between 2001 and 2010 cost 31–34 per cent more on average than properties in the earliest-built category. In terms of the regional location of buildings, the model shows a higher price for properties located in the South Great Plain compared to properties located in all other regions except Northern Hungary; however, this value was not found to be significant. According to the model, prices were 7–8 per cent higher in the third and fourth quarters compared to the first quarter, while there was no statistically significant price change in the second quarter of the year. This is somewhat different compared to the housing price index produced by the MNB. The aggregate nominal MNB house price index was 8 per cent, 6 per cent and 4 per cent higher in 2022 Q2, Q3 and Q4, respectively, compared to 2022 Q1.¹⁵ In part, this discrepancy may be due to the fact that our sample does not contain estimation data from January 2022. Additionally, properties in Budapest are overrepresented in the sample, where prices rose above the national average for the year as a whole.

¹⁵ Source: MNB Housing Price Index. <https://statisztika.mnb.hu/idosor-2612>. Downloaded: 7 April 2023.

Explanatory variables	(1) Unique ET values		(2) Grouped ET values	
	Coefficients	P-value	Coefficients	P-value
Energy performance certificate (control: JJ)				
II	-0.0077	0.8340	-0.1684	0.0000
HH	0.0467	0.1877		
GG	0.1200	0.0008	Control: DD–GG	–
FF	0.2149	0.0000		
EE	0.2319	0.0000		
DD	0.2455	0.0000		
CC	0.2870	0.0000	0.0729	0.0000
AA–BB	0.3520	0.0000		
Ln Base area	0.7498	0.0000	0.7549	0.0000
Year of construction (control: 1880–1940)				
1941–1980	-0.1036	0.0000	-0.0889	0.0000
1981–2000	0.1410	0.0000	0.1718	0.0000
2001–2010	0.3108	0.0000	0.3473	0.0000
2011–2020	0.2163	0.0000	0.2876	0.0000
Renovation (control: none)	0.0624	0.0000	0.0664	0.0000
Comfort level (control: Dwelling without comfort)				
Dwelling with some amenities	0.0742	0.0955	0.0749	0.0940
Dwelling with all amenities	0.1493	0.0007	0.1667	0.0000
Property type (control: detached house)	-0.0197	0.1682	-0.0360	0.0110
Region (control: Southern Great Plain)				
Southern Transdanubia	0.1102	0.0000	0.1145	0.0000
Western Transdanubia	0.2074	0.0000	0.2102	0.0000
Central Transdanubia	0.2566	0.0000	0.2588	0.0000
Central Hungary	0.4446	0.0000	0.4476	0.0000
Northern Great Plain	0.0295	0.1626	0.0318	0.1352
Northern Hungary	-0.0429	0.0946	-0.0446	0.0843
Ln Population size	0.0782	0.0000	0.0789	0.0000
Ln Distance from town centre	0.0007	0.8929	0.0011	0.8386
Q2 (dummy)	0.0107	0.5383	0.0141	0.4210
Q3 (dummy)	0.0703	0.0001	0.0744	0.0000
Q4 (dummy)	0.0753	0.0000	0.0805	0.0000
Number of items	4,400		4,400	
F-test	450.2		564.3	
R²	74.7%		74.3%	

Note: The sample includes properties that were appraised for mortgage purposes in 2022, and additional property characteristics are available specifically for the energy use and the energy performance certificates of buildings. The data are for municipalities with more than 1,500 inhabitants. Standard errors are robust for heteroskedasticity.

7. The result of the interaction between the energy crisis and energy performance certificates

The main values of the regression model estimated from equation (1) for the energy crisis and energy performance certificates are summarised in *Table 5. Annex 1* contains the full interaction model presented in *Table 5*, as well as a version of the model in which the dependent variable is the property's price per square metre. As the main conclusions of the study are not affected by changing the dependent variable, the regression results with the estimated market value variable are presented below. The energy performance certificates were split into three groups in the model, with the control group being the average energy efficiency properties. The coefficient of variation of the energy performance certificate in this case may be interpreted as follows: the average cost of energy-efficient homes (energy-inefficient homes) in the sample before the regulation of utility costs was 8 per cent more (12 per cent less) than average energy-using buildings. Both coefficients are statistically significant. The variable beta value for Q3 indicates that the value of the average category of houses in 2022 Q3 was 9 per cent higher than in Q2, controlling for other factors, while the variable beta for Q4 indicates that the value of the average category of houses in 2022 Q4 was 8 per cent higher than in Q2.

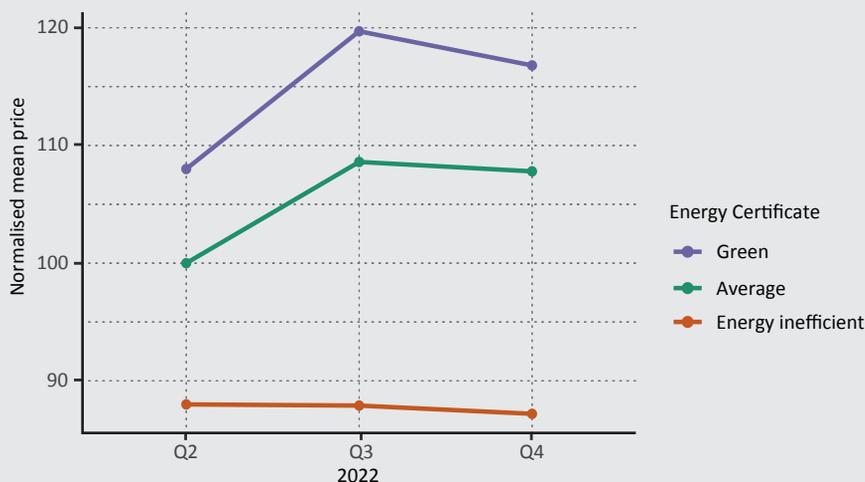
Table 5		
Result of linear regression on cross-effects		
	Coefficients	P-value
Energy performance certificate (control: DD–GG)		
Energy-efficient homes (AA–CC)	0.0782	0.0000
Energy-inefficient homes (HH–JJ)	–0.1175	0.0000
Quarter (control: Q2)		
Q1	–0.0169	0.3347
Q3	0.0861	0.0000
Q4	0.0786	0.0000
Q3 x Energy performance certificate		
Energy-efficient homes (AA–CC)	0.0316	0.2400
Energy-inefficient homes (HH–JJ)	–0.0850	0.0115
Q4 x Energy performance certificate		
Energy-efficient homes (AA–CC)	0.0090	0.7128
Energy-inefficient homes (HH–JJ)	–0.0862	0.0042
Number of items	4,400	
F-test	479.1	
R²	74.4%	

Note: The sample includes properties that were appraised for mortgage purposes in 2022, and additional property characteristics are available specifically for the energy use and the energy performance certificates of buildings. The data are for municipalities with more than 1,500 inhabitants. Other controls in the model include the floor area, year of construction, comfort level, region, population, distance from the town centre and a dummy which stands for a renovated property. Standard errors are robust for heteroskedasticity.

The effect of the interaction of the two variables is illustrated in *Figure 8*. In both quarters, the regression estimation yielded statistically significant results only for properties classified as HH–JJ when examining the interaction of the two variables. In the present case, this may be interpreted as the fact that in the first half of the year, an energy-inefficient property cost, on average, 12 per cent less than an average energy rated property after controlling for other effects, while in the period after the onset of the energy crisis, the difference is 20 per cent ($-11.75\%+8.5\%$ in Q3 and $-11.75\%+8.6\%$ in Q4). Similarly, when looking at the relative value of energy-efficient homes, it is found that before the residential energy price increase they were worth, on average, 8 per cent more than average energy-efficiency homes in Q2, while after the energy crisis the difference is 11 per cent ($7.8\%+3.1\%$) in Q3 and 9 per cent ($7.8\%+1\%$) in Q4, although the second coefficient is not statistically significant in either case. The statistically *non-significant* difference seen in the higher energy performance group compared to the average group may be explained by the fact that the best category is largely achieved only by new-build homes. These were priced very high due to high construction costs (*Bereczki et al. 2022*), among other things, and it is possible that demand in this category acted as a barrier to any further significant price increase.

The combined effect is shown in *Figure 8*. Adding up the coefficients of the quarters and the interaction terms, we find that after the energy crisis the value of the best-category houses increased by 12 per cent in the third quarter of the year, while the value of the worst-category houses did not increase, despite an average increase in house prices. In the fourth quarter, the value of houses in the best category were 9 per cent higher, on average, than in the second quarter (before the onset of the energy crisis), while the value of houses in the worst category was 1 per cent lower.

Figure 8
Changes in house prices based on the estimated coefficients of the model



Note: Indices, average energy-efficiency property in Q2 = 100, which is used as the benchmark for Q3 and Q4.

8. Limitations

The main limitation for the conclusion of the study is the identification of the energy crisis. While we believe that the most significant event for the value of energy performance certificates was the restructuring of the utility cost reduction, rumours of an energy crisis were circulating even before July, which means that we cannot rule out the possibility that it was already present in property valuations before that date. This would bias the interaction coefficients (of the energy performance certificates and post-energy crisis time periods) investigated in this study towards zero. It is also possible that different submarkets priced the impact of a potential utility cost price shock differently. For example, if buyers of energy-efficient homes rely on better information, that submarket may have experienced stronger re-pricing before July, which would result in a higher bias (towards zero) for the best energy performance certificates and the third/fourth quarter interaction terms compared to other interaction terms. It is important to note here that in this study, market processes are only reflected in the data through the intermediation of appraisers.

The study uses the identification assumption that other events unrelated to the energy crisis had no impact on the relative value of energy performance certificates after July.

In the absence of a longer time series, it is not possible to check the extent of the correlation of the movement of prices of different energy classes in the past. Was the separation of prices in our study typical in the past? Going back to the beginning of 2021, the MNB's Housing Market Report shows that the price index for i) gas-heated mortgaged properties with energy consumption above the cut-off threshold for utility prices and ii) for mortgaged properties consuming reduced-priced energy only, moved together during 2021 and early 2022, and only diverged during 2022 (MNB 2023).

Another limitation of the study is that not all data were available for the control variables of the regression model (e.g. number of bathrooms, distance from school/grocery store, etc.). The impact of quantified energy performance certificates may therefore include the impact of other factors, such as the external appearance of the property.

The impact of the 2022 energy crisis on energy performance certificates has not yet been studied in the literature in this form, which may be due in part to the fact that the problems related to energy security and volatility of energy prices have yet to be resolved. We believe that, despite the short timeframe, it is worth investigating at an early stage, since the results show that the real estate market is expected to undergo significant shifts in energy use, including energy performance certificates. The fact that the energy crisis has had a significant negative impact on

house prices for buildings with below average energy efficiency is in line with the results of research in Hungary that show that energy modernisation plays a major role in the pricing of the property market.

9. Summary

The study examines the relationship between house prices and energy performance certificates in Hungary, with a particular focus on the impact of the changes in utility prices in the early months of the energy crisis. The issue is particularly topical in the light of the energy crisis caused by the Russian-Ukrainian war in 2022 and the global climate crisis. Our results are based on a unique database of mortgage data from a commercial bank in Hungary. By investigating the effect of an unexpected shock, the study brings us closer to understanding the causal relationship between energy performance certificates and house prices. Most of the available literature has taken a different approach. Our data cover a wide range of property types and the entire territory of the country. The study uses linear regression estimation similar to previous research in the literature.

In line with international literature and the results of studies on individual segments of the Hungarian residential real estate market, the energy performance certificates of real estate explain the house price in 2022 in a statistically and economically significant manner. The better the rating of a home, the higher its price. On a 12-point scale, a GG rating means an average of 12 per cent higher value compared to the worst category (JJ), while the highest rating (AA–BB) translates into a 35 per cent higher property value when controlling for other factors. Examining the energy performance certificates as three separate groups, energy-efficient homes (AA–CC) yield a 7 per cent higher price compared to average-rated (DD–GG) properties, while energy-inefficient buildings (HH–JJ) cost 17 per cent less on average. Examining the interaction of the 2022 energy crisis with certificates, it can be observed that before the energy crisis an energy-inefficient property cost, on average, 12 per cent less than an average energy-rated property when controlling for other impacts, with this difference rising to 20 per cent in the period after the onset of the energy crisis (Q3 and Q4). The relative value of energy-efficient homes shows that before the energy crisis hit in August 2022 such dwellings were worth, on average, 8 per cent more than average energy-efficient homes in Q2, while after the energy crisis, this difference increased to 9–11 per cent.

The results of the research relate to the early stages of the energy crisis and can therefore be taken as an indication. The study shows that energy performance certificates are priced by the market and their role has grown since the energy crisis began. For Hungary, the market also shows that it is increasingly important to increase the energy efficiency of the housing stock. A large proportion of Hungarian properties

were built before the end of communism and do not reach the required level of energy efficiency or do not have a heating system that can effectively protect them from the increased utility costs caused by the energy crisis. The modernisation of the building stock is not only important at level of individuals in order to maximise profits, but also at the government level, based on considerations related to sustainability and energy dependence. In the future, it may be worthwhile to establish a unified framework for promoting energy efficiency in housing, including precise targets and the means of implementation and support needed to achieve them.

This study serves as a basis for further research and as a preparatory work for policy decisions. Another important question may be how much of an incentive homeowners have to upgrade to energy efficiency given the current pricing of energy efficiency in the housing market, and how incentives can be most effectively and efficiently increased. A possible broader energy modernisation scheme would not only reduce costs for the population, but would also ensure progress towards climate goals by developing systems using renewable energy sources.

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Annex

Annex 1				
A full interaction model for the original variable and the dependent variable log (price/m²)				
Explanatory variables	(1) Interaction		(2) Interaction (price/m ²)	
	Coefficients	P-value	Coefficients	P-value
Q1 (control: Q2)	-0.0169	0.3347	-0.0154	0.4253
Q3 (control: Q2)	0.0861	0.0000	0.0920	0.0000
Q4 (control: Q2)	0.0786	0.0000	0.0898	0.0000
Energy performance certificate (control: DD–GG)				
Energy-efficient homes (AA–CC)	0.0782	0.0000	0.1139	0.0000
Energy-inefficient homes (HH–JJ)	-0.1175	0.0000	-0.0912	0.0000
Q3 x Energy performance certificate				
Energy-efficient homes (AA–CC)	0.0316	0.2400	0.0407	0.1683
Energy-inefficient homes (HH–JJ)	-0.0850	0.0115	-0.1072	0.0038
Q4 x Energy performance certificate				
Energy-efficient homes (AA–CC)	0.0090	0.7128	0.0058	0.8294
Energy-inefficient homes (HH–JJ)	-0.0862	0.0042	-0.0935	0.0048
Ln Base area	0.7544	0.0000	–	–
Year of construction (control: 1880–1940)				
1941–1980	-0.0885	0.0000	-0.0990	0.0000
1981–2000	0.1727	0.0000	0.0514	0.0441
2001–2010	0.3477	0.0000	0.2314	0.0000
2011–2020	0.2875	0.0000	0.1669	0.0000
Renovation (control: none)	0.0663	0.0000	0.0788	0.0000
Comfort level (control: Dwelling without comfort)				
Dwelling with some amenities	0.0814	0.0688	0.0813	0.0986
Dwelling with all amenities	0.1714	0.0001	0.0855	0.0774
Property type (control: detached house)	-0.0359	0.0109	-0.2649	0.0000
Region (control: Southern Great Plain)				
Southern Transdanubia	0.1137	0.0000	0.0733	0.0144
Western Transdanubia	0.2094	0.0000	0.1996	0.0000
Central Transdanubia	0.2586	0.0000	0.2187	0.0000
Central Hungary	0.4469	0.0000	0.4094	0.0000
Northern Great Plain	0.0324	0.1266	0.0380	0.1036
Northern Hungary	-0.0446	0.0835	-0.0710	0.0123
Ln Population size	0.0790	0.0000	0.0888	0.0000
Ln Distance from town centre	0.0009	0.8646	-0.0116	0.0567
Number of items	4,400		4,400	
F-test	479.1		305.4	
R²	74.4%		64%	

Note: The sample includes properties that were appraised for mortgage purposes in 2022, and additional property characteristics are available specifically for the energy use and the energy performance certificates of buildings. The data are for municipalities with more than 1,500 inhabitants. Other controls in the model include the floor area, year of construction, comfort level, region, population, distance from the town centre and a dummy which stands for a renovated property. Standard errors are robust for heteroskedasticity.

The Long Road Towards Women’s Equality in the Labour Market – Claudia Goldin’s Research on Historical Trends and Contributing Factors*

Judit Edit Futó  – Anna Lovász 

Claudia Goldin won the 2023 Nobel Prize in Economics for her research on women in the labour market. Her body of work provides a broad, data-driven, historical overview of gender inequalities and evidence of the impacts of specific changes and institutional elements. We review her main findings regarding the evolution of women’s employment and earnings in light of key historical events. She documented a U-shaped labour supply curve over time, which challenged past notions of a monotonous positive relationship between economic development and women’s labour supply. Her work brought attention to complex forces that shaped the past, such as the rise of factory jobs, service-sector jobs and the contraceptive pill. Her research also points to remaining causes of inequalities, such as high-earning professions that disproportionately favour long work hours and continuous job attachment. Her work contributes to our knowledge of this social issue and has catalysed new areas of research.

Journal of Economic Literature (JEL) codes: J1, J31, J71

Keywords: Nobel prize, women’s labour market participation, gender pay gap

1. Introduction

As with many topics, the public discourse on gender equality in the labour market is often dominated by views at the two extremes. On the one side, the gender employment and pay gaps are often cited as evidence of discrimination against women, an injustice that still needs to be addressed. On the other side, many point out that women now have equal (or even higher) education levels as men, and they earn (almost) equally within occupations. They argue that the remaining gender gaps are simply a result of women’s own choices, and we do not need further policies or efforts aimed at equalising outcomes. It is statistical fact that

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today, in most developed countries, a large part of the gender pay gap is explained by occupational differences and the lower work hours of women. Once these differences are controlled for, the unexplained gender pay gap is much smaller, although still not zero.¹ It is also clear that parenthood impacts men's and women's earnings and career trajectories very differently.² However, this is where the true debate begins. Are the different choices made by men and women due to innate differences in preferences and skills, so there is no need to address them? Or are they a result of remaining constraints on women's opportunities and aspirations, such as societal expectations, which should be addressed?

Rather than imposing pre-judgements of the role of nature versus nurture, the goal of scientific research is to maximise society's welfare by providing data-based evidence of the causes and impacts of these gaps. Such evidence can then be used to develop policies that help remove any obstacles that may be hindering women – and men – from utilising their abilities in an optimal way. Developing policies that allow individuals to achieve “outcomes that reflect their underlying abilities” (Niederle 2016) requires research on a wide range of factors related to educational and career incentives and opportunities. Goldin's body of work provides exactly this kind of data-driven, nuanced big picture view. A review of her findings reveals the evolution of our knowledge of gender inequalities. Her research shows how women's (and men's) opportunities and labour market outcomes evolved over time, due to economic development, institutional and labour market changes, and shifts in social norms. While her work focuses on the situation of American women, it led to similar avenues of research on many countries.³ This evidence can inform our expectations of how gender equality may develop in the future and serve as a basis for determining what policies can aid us in utilising women's and men's abilities and skills more efficiently as a society.

¹ In the US, the raw, or unadjusted gender gap in median earnings was 17 per cent in 2022 (OECD), while the unexplained or adjusted gap (the earnings gap we see after controlling for gender differences in characteristics such as education, occupation, work experience, region, and union status) is around 7 per cent (Economic Policy Institute 2016). Blau and Kahn (2016) document an unadjusted gap of 20.7 per cent, and an adjusted gap of 8.4 per cent.

² The motherhood penalty (lower earnings of mothers compared to non-mothers) has been documented in many countries; however, its magnitude varies greatly depending on institutions, family policies, and societal norms (Cukrowska-Torzewska and Matysiak 2020). The penalty is the lowest in countries that support parents' ability to balance childcare needs and work with widely available, affordable childcare and well paid, reasonably long leaves that can be shared by mothers and fathers. Bertrand et al. (2010) show that in the US, parenthood contributes significantly to earnings inequalities that develop over men's and women's lives through reductions in work hours and career interruptions.

³ In Hungary, there has also been a strand of studies focused on gender inequalities in the labour market. These include analyses of the gender pay gap (Takács 2021), occupational segregation (Ilyés – Lőrinc 2022), childcare availability (Lovász – Szabó-Morvai 2019), and the glass ceiling (Adamecz 2018).

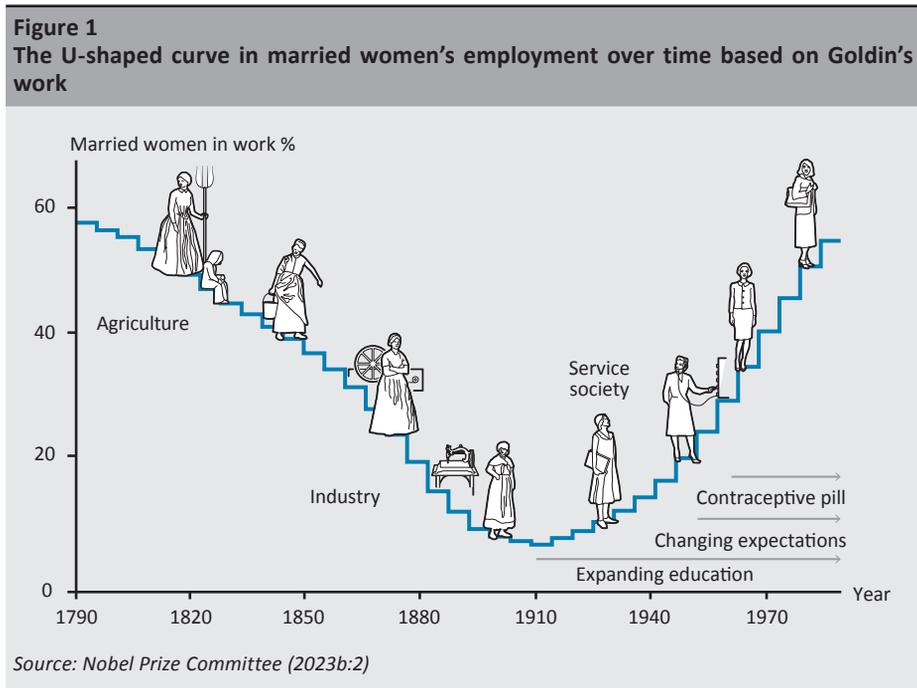
Before describing Goldin's research findings in detail, it is important to highlight why Goldin's prize is special in the history of Nobel Prizes. She received the Nobel Memorial Prize in Economics in 2023 for her research furthering the understanding of the role of women in the labour market, an area of study that was outside of mainstream economics when she started her research. Her contributions brought attention to a key issue and helped set off an ever-growing body of literature. She is the third woman to receive the Nobel Prize in Economics, preceded only by *Elinor Ostrom (2009)* and *Esther Duflo (2019)*, but both were shared winners (*Nobel Prize 2023*), while Goldin is the first to earn the prize for economic research alone. Furthermore, economic historians rarely receive the Nobel Prize in economics. In fact, the last economic historian to win one was Goldin's supervisor Robert Fogel, who shared it with Douglas North in 1993. Goldin cultivates the kind of economic history known as cliometrics, a method of economic analysis in which the theoretical and empirical apparatuses of economics are applied to the investigation of economic historical questions (*Cliometric Society 2023*). Most of Goldin's work involved the compilation of historical databases. Rather than revolving around a big idea or a theoretical model, this type of work consists of persistent, meticulous work as a historian. At the same time, the unified labour supply and demand framework Goldin used to analyse historical changes in gender inequalities also contributed more broadly to the field of economics. Her work drew attention to income and substitution effects in labour supply decisions, the impacts of self-selection into labour markets, and the interactions between markets and households. Research has highlighted further inequalities in health, education, personal autonomy and legal rights, and trends in inequalities have been related to industry structure, aggregate productivity and the efficiency gains from the allocation of talent.

Goldin's life path can be considered relatively uneventful. She attended prestigious universities such as Cornell and the University of Chicago. She received her PhD from the University of Chicago in 1972 under the supervision of Robert Fogel, whose supervisor was Simon Kuznets, who also received the Nobel Prize in 1971 (*Nobel Prize 2023*). She also maintained a close working relationship with Gary Becker, who received the Nobel Prize in 1992 (*Nobel Prize 2023*). Since 1990, she has been a professor at Harvard University, where she is the first female tenured professor in the economics department (*Goldin 2023*). Goldin is not the only economist who has carried out important research on the labour market differences between women and men. Before Goldin, we can point to the names of Ester Boserup or Gary Becker. However, today Goldin is considered to be the number one researcher in this topic, as evidenced by countless articles related to her name in the syllabi of Labour Economics courses at every university (*Adamecz – Isztin 2023*).

In the following sections, we summarise Goldin’s key findings related to the evolution of women’s labour supply over the last centuries and the main factors shaping these trends. We discuss her research on the gender earnings gap and underlying causes that still contribute to the gap today. We then discuss her findings related to issues related to work-life balance that are still hindering women in their careers and conclude by describing how her work led to fruitful further avenues of research on gender inequality.

2. Women’s labour supply over time

Goldin’s main contribution to the study of gender inequalities is that her research has significantly improved our understanding of the forces shaping women’s participation in the labour market. Note that labour supply, or labour market participation, refers to the number of women who are employed or actively looking for employment. *Figure 1* is a key summary figure that represents the results of her analysis of over two hundred years of data: the U-shaped curve in female labour supply curve. The figure indicates the main factors behind the U-shaped pattern over time and highlights the importance of married women’s return to the labour market and what it meant in terms of the cohort⁴ effects studied by Goldin.



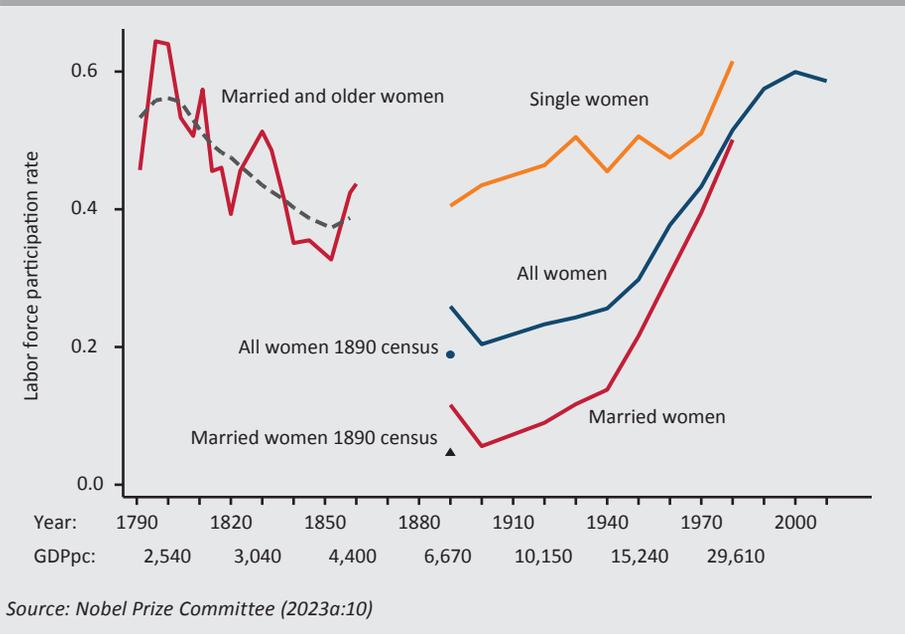
⁴ “The term “cohort” means a group born within some time interval and refers here to various constructed measures, rather than to the actual movements of individuals over time” (Goldin 1990:19).

Over the past few centuries, society has changed significantly. Since the industrial revolution, contemporary industrialised countries have achieved continuous economic growth. As a result, it would be easy to assume that the trend of women's participation in the labour market followed suit. However, Goldin's work showed that this is not the case (*Nobel Prize Committee 2023b*). Her book, published in 1990, entitled "Understanding the gender gap: an economic history of American women" can be considered a milestone in the research on this topic. It expanded the scope of and added depth to our knowledge significantly, as Goldin did not limit her analysis to recent decades, but rather looked back over the past 200–250 years.

As described by the *Nobel Prize Committee (2023b)*, Goldin used *the rearview mirror* to examine how the female labour force changed as the economy was transformed. To do so, she combined the methods of economic history and economics, resulting in a deeper understanding of the historical development of women's participation and employment. This work required meticulous data collection efforts and ended up challenging the validity of existing statistics and assumptions related to women's employment. Historical data collected on women's work were often underreported, and Goldin corrected for this by examining data sources working as a sort of detective. She researched the long-forgotten past by collecting information from various historical sources available in archives, such as diaries and accounts kept by widows (*Goldin 1990*).

In the 19th century, US census data was used to document a gradual increase in female participation rates. Goldin, however, questioned the quality of this database since there was hardly any accurate data from before 1940. She collected a large amount of previously unused quantitative and qualitative information, based on which she had more accurate data reaching back to the late 1700s. As a result, her work corrected previous participation statistics from 1790 to 1900 (*Nobel Prize Committee 2023a*). In analysing this new statistical data, Goldin identified a different pattern in the historical development of female employment (*Figure 1*) and labour market participation (*Figure 2*). This pattern resembles the letter U, in other words, in the US, the female employment and participation rates first decreased and then increased over time. Based on these figures, Goldin highlighted that, in contrast to earlier assumptions, the period of growth in labour supply in the 20th century was actually preceded by a decline throughout the 19th century.

Figure 2
The U-shaped curve in women’s labour supply over time based on Goldin’s work



2.1. Reasons behind the descending branch of the U-shaped curve

Goldin’s body of work provides a detailed look at the causes behind these changes through the exploration and analysis of the U-shaped pattern (Goldin 1986, 1990, 1995, 2002, 2006). In the highly influential book mentioned earlier (Goldin 1990), she addresses the role of women in the American economy, the history of the development of the female workforce, and the differences between women and men in terms of earnings and occupations in great detail. Her research placed a special emphasis on examining the changes in the societal roles of married women, which contributed greatly to the development of the U-shaped pattern. Goldin (1990) describes the reasons why the female labour force was underestimated in historical censuses and includes a discussion of the biases present in the definitions used during the accounting. By changing the interpretation of the definitions, Goldin was able to better capture the changes in the participation rates of women. Her expansion of the available historical data over time contributed greatly to a better understanding of women’s labour market participation.

For example, in the census reports, particularly before the 1940s, the term wife was used as an occupation title for those who were married, and these women were not included in the labour force based on the concept of gainful employment (Goldin 1995). Evidence from Goldin’s research (Goldin 1990, 1995) led to the

realisation that women who are married should not be automatically assumed not to work because they are housewives. It was also not uncommon for small farmers, agricultural workers, guesthouse managers, or other small business owners to work together with their wives. Additionally, women often worked in the cottage industry or produced dairy products and clothing at home, however, these activities were not well recorded in the historical data. From the modified statistical data, Goldin found that the employment rate of women in the American labour market in the late 1890s was almost three times higher than the census data showed (*Nobel Prize Committee 2023b*).

Many more women worked for wages or produced for market in their own homes or on their own farms than were registered in the census. However, Goldin showed that the income effect was negative; that is, an increase in income reduced the quantity of work offered. This was due to the fact that society looked down on married women who worked at that time, and it was a kind of stigma for these women (*Goldin 1995*). As industrialisation progressed, until the end of the 19th century and the beginning of the 20th century, women's participation in the labour market continued to decrease. The bottom of the U-shaped function, where it changes direction, is thought by *Goldin (1995)* to be in the 1920s. Based on the corrected data, *Goldin (1990)* summarises that the undercounting problem was much greater in the census periods before 1890. If we look at the statistics she supplemented, we can see a clear decrease in the female workforce, as well as how many married women did "hidden market work" (*Goldin 1986*).

With the American industrial revolution, the number of people working in agriculture decreased because they started working in the emerging factories, and thus many small rural businesses disappeared. *Goldin (1986)* examines the presence of older and married women in the labour market during this period in detail. She collected data on more than 12,000 households headed by unmarried or widowed women between 1791 and 1860 in Philadelphia. Data were from 27 city libraries and 3 state censuses. Goldin chose this region because it was the largest city and the capital of the US at that time. In this pioneering work, *Goldin (1986)* showed that many married women were working, even though this was not counted as work in the census. These were, for example, the jobs of seamstresses, boarding house managers, and laundresses, which they did at home together with their husbands.

Using an innovative quantitative analysis, Goldin examined the diaries of widows, for example, and came to the conclusion that in the 1790s, widows carried on the business of their successful husbands at a high rate. Thus, widows inherited professional experience that enabled them to become shoemakers, ironmongers or shop assistants. Goldin drew the important conclusion that many of these women were engaged in hidden market work even when their husbands were alive.

Her finding suggests that, with economic development, the labour force participation rate of married women first falls and only later rises (*Goldin 1986*).

Goldin also examined the situation of single, young women during this period, for whom industrialisation provided only supplementary work in some states according to their ability (*Nobel Prize Committee 2023a*), but even so, their employment declined from the second half of the 19th century. *Goldin (1990)* saw the reason for this decrease in the fact that society started to raise questions related to the growing number of female workers, such as whether women have the right to work, and thereby drew attention to a series of protective measures. Strong social norms, for example, that a woman should not work if she is already married, resulted in the fact that sooner or later single women who worked in the labour market ended up getting married, so even if they had a job, they gave it up. The American Industrial Revolution and social norms both reduced the opportunities for women to balance work and family life (*Goldin 1986*).

Based on *Goldin's (1986)* research, the labour force participation data for female heads of households show a seventy-year average of around 44 per cent with a slight downward trend. In many cases, the factors revealed by Goldin's research that were responsible for the decline were operating in opposite directions. Industrialisation and economic development reduced the presence of older women in the labour market. The movement of labour from the household to the market decreased the transmission of business knowledge within the family and the ability of widows to take on the responsibilities of their husbands' crafts. Related to this, the separation of the place of work from place of home increased the cost of participating in the market economy, particularly for women with young children.

The data collected and corrected by Goldin revealed that the well-known 20th century growth in the supply side of female workers was preceded by a sharp decline throughout the 19th century. Goldin's work also influenced others, contributing to the development of wider research on the topic (*Nobel Prize Committee 2023a*). *Goldin (1995)* examined a number of developing countries in terms of the historical development of female employment over time and found that a similar type of U-shaped function can be seen in other countries as well. These findings had broader implications for economic analysis, beyond the topic of gender inequalities. Economic theory suggests that the overall impact of higher earnings depends on two different channels: the income effect, which suggests that higher earning potential translates to women's higher desire to participate in the labour market; and the substitution effect, which suggests that higher earnings lead to women choosing to stay within the home, focusing more on unpaid work such as childcare when income constraints ease. Goldin's discovery of the U-shaped curve called into question whether income and substitution effects should be assumed to

be fixed over the process of economic development (*Goldin 1995*). In other words, there is no historically consistent association between the participation rate of women and economic growth. *Goldin (1995)* suggested that the reasons behind the change in the direction of the women's labour supply trend may be due to changes in the magnitude of the substitution effect relative to the income effect. During this time period, the substitution effect increased and exceeded the income effect, leading to a decrease in women's labour supply.

2.2. The role of married women in the development of female employment

The increasing section of the U-shaped function and the underlying causes are discussed by one of Goldin's most influential studies (*Goldin 2006*). From the end of the 19th century, the female employment rate began to increase. She examined this 80-year long period and established the important role played by married women and cohort effects during that time. Additionally, *Goldin (1990)* also highlights that technological progress, the growth of service sector and increased levels of education added to the increasing supply of female labour. Until the first half of the 20th century, legislation, social stigma and other institutional barriers restricted the effects of these factors. *Goldin (1990, 2006, 2021)* established that there were three important changes: the expansion of education, changing expectations and the introduction of the contraceptive pill that played a prominent role in the growth of female employment. We next describe the distinct time periods analysed by *Goldin (2006)* and the driving forces behind their trends.

Goldin (2006) examined changes in the role of women in the economy, including the participation of women in the labour market in the US. She distinguished four main stages, referring to the first three as the evolutionary stages, and the fourth as the revolutionary stage, which she called "the quiet revolution". She analysed the difference between the two concepts based on three factors. The first is the horizon, where the length of time of women's labour market presence is taken into account. The second is identity, that is, whether women find their identity in their work. And the third is decision making, which looks at whether the presence of women in the labour market is the result of a joint decision if the woman is married, or if the woman is a "secondary worker" who adjusts her time to her husband's work.

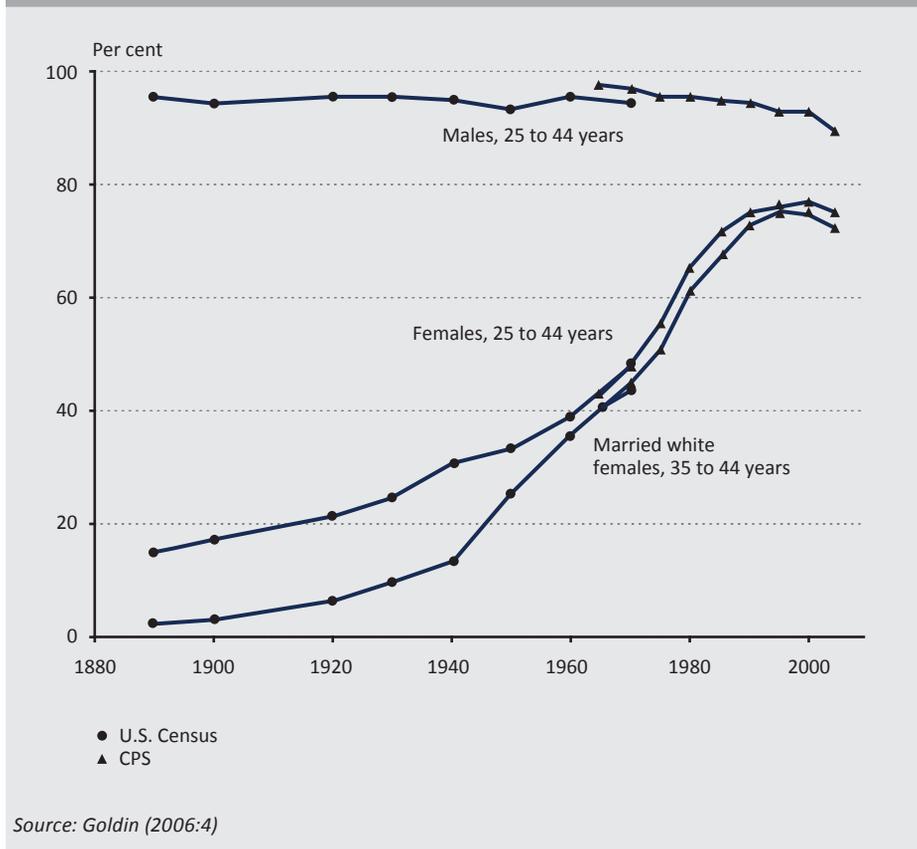
2.2.1. The evolutionary stages

The first phase was referred to as that of the independent working woman, which spanned from the end of the nineteenth century to the 1920s. Most working women were young and unmarried at that time. The most common jobs for them were piece workers and household jobs (cleaners, laundresses). A very small number of them were professional workers, mostly teachers and office workers. Their number increased significantly in the 1910s. Most of the working women were

undereducated and stopped working when they got married, except for the poorest and the most educated. Sociopolitical issues such as equal pay, the minimum wage and the maximum number of working hours entered public consciousness at this time.

The next phase spanned from the 1930s to the 1950s, and in this phase it became easier for married women to enter the workforce. Based on *Figure 3*, from 1930 to 1950, the share of married women in the labour market increased significantly. In 1890, 8 per cent of working women were married, in 1930 it was 26 per cent and in 1950 it was 47 per cent.

Figure 3
Labour force participation rates for females and males by age and marital status, 1890 to 2004



The participation of female force in the labour market increased due to two factors: the first was an increase in demand for office workers and the second was the rapid increase in high school education rates (*Goldin 2006*). In 1900, 24 per cent of office workers were women, while in 1930 the ratio had increased to 52 per cent. This meant that young women could work in cleaner, more pleasant environments, with shorter working hours, and thus in more “respectable” workplaces before getting married.

Until 1940, there was legislation in place called the marriage bar that prohibited the hiring of married women, and newly married women had to leave the labour market (*Goldin 1990*). The modern concept of the labour force first appeared in the 1940 census, and the concept of gainful employment that was previously used changed (*Goldin 1995*). As a result, this is when part-time jobs first appeared in the data. At the same time, with the appearance of modern household appliances such as refrigerators and washing machines that freed up women's time, the aggregate labour supply of women increased.

Economists studying the labour market began to examine how husbands' income affected their wives' presence in the labour market. They found that the two values are negatively correlated. However, by the end of this time period, the correlation began to decline sharply. If it had not decreased, then the presence of married women in the labour market could never have increased significantly.

Goldin (2006) defined the third evolutionary stage as spanning from the 1950s to the 1970s, which she viewed as the roots of the Quiet Revolution. The presence of married women in the labour market continued to increase during this period. Part-time work became more and more widespread, and the proportion of women working less than 35 hours per week increased from 18 per cent in 1940 to 28 per cent in 1960. Provisions restricting the employment of married women were completely abolished. Married women were still considered secondary earners within households. Secretaries, teachers, nurses, social workers and librarians were the most common occupations for women. Opportunities for advancement were limited, and women were most often asked how fast they could type in job interviews.

Even though women were employed during most of their lives, their expectations differed significantly from those of men based on surveys of young women. Most were prepared to engage in short and temporary employment in various jobs, rather than thinking about a career. For most, attending a university was seen as a way to find the right spouse, not as the first step in a career. During this period, as

real wages increased, the employment of married women also increased, but the difference in earnings compared to men decreased only slightly.

2.2.2. *The quiet revolution*

The final stage in the evolution of women's labour market participation started from the late 1970s and continues to this day. Goldin refers to this phase as the Quiet Revolution. The growth in the labour market presence of women that occurred in the previous stage was an important prerequisite for the quiet revolution, but it is not an indicator of it. We discuss two main indicators here: the horizon and women's identity.

Based on *Goldin (2006)*, the expanded horizon means that women were able to predict their future careers more and more accurately. With these more accurate expectations they were able to invest in their education in better ways, and be hired into positions where they had more opportunity for advancement. They were now able to plan a career, not just a job. In the 1970s, young women increasingly expected to work later in life, unlike their mothers' generation. In the 1970s and 1980s, young girls enrolled in more and more college preparatory courses during high school and improved their scores in math and reading assessments. As a result, the proportion of female students in higher education increased significantly. This, in turn, impacted other decisions related to forming families: the median age at marriage for women with a degree was 25 years, compared to the 22.5 year median typical of the previous era. During this era, more and more women acquired legal, medical, pharmaceutical and economic training.

The other key indicator highlighted by Goldin relates to women's altered identities. A revolution could also be seen in changes in women's self-image. Since women got married later, they were able to "make a name" for themselves before having to change their name upon marriage. In the 1970s, almost all women took their husband's name, and in 1990, about 20 per cent of women who graduated from university kept their own name when they got married. Based on surveys conducted among university students starting in the 1960s, personal success (career, recognition) became more important to more women over time, and the importance of family became equally important for women and men. However, financial success was still seen as more important for men. The workplace became a key element of individual identity, even for lower-educated people. More and more women entered the labour market significantly better prepared and with the goal of having a successful career. Women's earnings increased compared to men's, so the gender difference in earnings decreased significantly. An increasing number of women became doctors, professors, lawyers and managers.

Based on Goldin's research, higher investments in education and changes in the expectations of married women and women in general were the main driving forces behind the increase in the female employment rate in the 20th century, despite the fact that many formal and informal barriers had also been eliminated. From the end of the 1960s, however, the research of *Goldin – Katz (2002)* drew attention to another key change, demonstrating the power of the pill. They showed that the availability of the birth control pill had a transformative role in shaping women's opportunities and contributed greatly to the development of the quiet revolution. Goldin and Katz found that the pill resulted in women investing more in their education because it allowed them to plan the timing of their marriage and childbirths more easily.

On a related note, *Goldin and Rouse (2000)* explored the role of discrimination in hiring using a quasi-experimental change in the hiring practices of major American symphonic orchestras in the late 1970s. The abolition of the marriage bar and open discrimination did not put an end to subtler discriminatory practices. Symphonic orchestras were historically composed of mostly males, and conductors often expressed a preference for male musicians. However, over time, the number of female musicians increased significantly. Goldin and Rouse utilised the fact that there was a change in the audition procedures of these orchestras in order to study whether discriminatory practices were present. The orchestras adopted blind auditions, where a screen concealed the candidate's identity from the hiring committee, while earlier, auditions were conducted face-to-face. Analysis of data on auditions, audition types, musicians and outcomes showed that blind auditions increased the probability that women advanced to the next round and were hired. This suggested that employer gender discrimination in hiring was still present. However, it also suggests that hiring practices such as blind auditions can successfully decrease the realised impacts of discriminatory preferences.

3. The gender gap in earnings

Goldin's work has also added key insight to our knowledge of the causes behind the gender earnings gap. The earnings gap did also not relate linearly to economic growth. It was relatively low during the industrial revolution between 1820–1850, increased during 1850–1930, held steady between 1930 and 1980, and decreased markedly around 1980 due to improvements in human capital and work experience, before plateauing around the current level in the last few decades.

Goldin (2014) summarises the convergence of earnings and highlights a key factor behind remaining inequality. She argues that rather than governmental policies,

further improvements in the relative pay of women must stem from changes in the labour market and firms' policies. The way work hours are organised and remunerated in many professions, and in particular many high-earning professions, disadvantages women by rewarding long work hours and inflexible schedules. Since, as time use data shows, women still take on more household and care duties than men even when they work full time, they are not able to stay at work longer or work on nights and weekends and thereby achieve promotions and higher pay.

Bertrand et al. (2010) studied the evolution of the earnings of MBS graduates over the course of their lives. They found that while the earnings of recent male and female graduates are nearly identical when they enter the labour market, their earnings gradually diverge over time, with males earnings 60 log points more one decade after they graduate. They show that this can be explained in a large part by female graduates' shorter work hours and career interruptions, which are related to motherhood. This suggests that women still choose between their family and careers, in the sense that they are not able to compete with men in terms of work hours once they have children, and therefore suffer a disadvantage in terms of promotion and earnings growth.

However, as *Goldin (2014)* points out, this disadvantage of women can be decreased if workplaces allowed more intertemporal flexibility, without penalising fewer work hours. *Goldin and Katz (2016)* illustrate this based on the gender earnings gap and part-time earnings penalty within the pharmaceutical industry. They show that technological advances, which allowed pharmacy workers to become more easily substitutable, led to more flexible schedules and a lower penalty for part-time work. This, in turn, made this one of the most gender-equal industries in terms of the gender earnings gap. Some further professions such as IT and healthcare have similarly achieved gender convergence in earnings through increased temporal flexibility. On the other hand, professions in the legal, financial and corporate sectors tend to reward long work hours and labour market attachment more, leading to larger gender earnings gaps.

4. The development of the relationship between family and career

Some of Goldin's further work provides even deeper insight into the forces shaping women's labour market outcomes, in light of changes in their opportunities in terms of balancing work and life responsibilities. Based on what has been described so far,

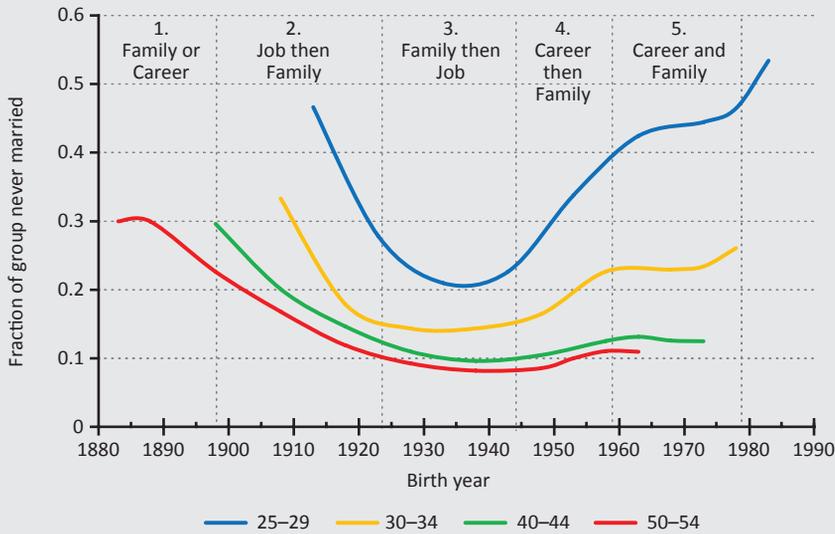
Goldin (1990, 2006, Goldin – Katz 2002) attributed the increase in the participation rate of women's labour supply from the beginning of the 20th century to the following three main reasons (along with many other formal and informal factors): lifelong learning; changes in women's expectations and their identity; and legalising the birth control pill. As a sort of summary of her work so far, *Goldin* pointed out in her 2021 book entitled "Career & Family: Women's Century-Long Journey toward Equity" that it is very useful to distinguish between five generations of American college-graduated women in order to understand the development of the labour market over the past 100 years.

The differentiation among the groups concentrated on their aspirations, and on the decisions that they made between employment and family. Women faced barriers in both areas throughout the century, such as marriage bars or limitations in many positions. *Goldin* used birth year as the determinant factor in the classification. Within each group, women are largely uniform in terms of the constraints they faced, and the aspirations formed within the limits of those constraints. Although the groups were different, each one passed a meaningful baton (guideline) on to the next generation.

In order to reach a more precise understanding of the changes in women's choices, ambitions and opportunities over the past century, *Goldin* created reliable definitions of "the family" and "the career." Based on *Goldin (2021:20)*, "family is defined as having a child," and the expression "career" is not limited to just having a job. For the women she analysed, a career is defined as "long-lasting, sought-after employment for which the type of work often shapes one's identity."

Goldin (2021) highlighted that the age of marriage is an important indicator distinguishing among the various groups. The five groups she defined are referred to as: Family or Career; Job then Family; Family then Job; Career then Family; and Career and Family (*Figure 4*). Whether a woman marries late, early, or not at all, the decision is related to her plans for a career and for having children. *Goldin's (2021)* found a general U shape in the fraction of college-graduate women who remained never married by age.

Figure 4
Fraction of College-Graduate Women Never Married by Age and Birth Group



Source: Goldin (2021:34)

The main characteristics of these five groups shed light on the evolution of women’s situation in the labour market and within households. The first group was composed of white college-graduate women who were born around the 1880s. They still had to choose between family and career. Those who chose to pursue a career generally gave up on having a family and having children. The members of the next group were born at the beginning of the 20th century and got married relatively later. The example they learned from the previous generation was that they had to give up their careers and accept that they would first have a job and then start a family. Due to the influence of marriage bars, they also accepted that after starting a family they could no longer work. The third group included college-graduate women who were born around 1930 and got married at a young age. They had a large number of children and, after starting a family, continued their studies and went to work. All of this was possible due to the easing of labour market restrictions.

The fourth group is characterised by the fact that it is composed of women who are married, have children, have a job and work under better labour market conditions. This is because most of the members of this group graduated around the 1970s, the period of the quiet revolution. The women of the previous generation could not build a career, they only had jobs, but this changed in the case of the fourth group. The children of the quiet revolution wanted to see their work as a lifelong vocation, i.e. they wanted a career before a family. The liberalisation of divorce also

shaped women's views, as the facilitation of divorce made it more risky to invest in husbands' human capital but not in that of their wives.

The fifth and final generation includes those born since 1958, who graduated around or after 1980. These women again enjoyed a broadening of opportunities and improved labour market outcomes. Advances in medical technology and social changes have enabled them to balance their careers and families more than any previous generation of women. In the words of Goldin (2021:44):

"Each group took the baton and ran an additional length of road, jumping hurdles and trying to dodge barriers. And each generation has been faced with ever-changing constraints – as well as a host of technological advances, in the household and related to reproduction, that have smoothed the path forward."

5. Conclusion

Goldin's research has not only reshaped our knowledge of the key forces that determine gender inequalities in labour market outcomes. It has also shaped the evolution of research in economics related to this topic. Her work drew attention to the importance of these issues and the complexity of the causes behind them, and opened up a blossoming literature investigating the impacts of governmental policies, corporate incentives, psychological differences, and social norms and stereotypes. Her analyses of gender inequalities are far-reaching in scope, demanding in terms of data collection and innovative in that she presented her empirical findings within a unifying framework of labour supply and demand. She started her work on this topic at a time when she was one of a few female economists at top institutions and when research in this area was not encouraged or appreciated. Her dedication, hard work and persistence have opened the door for many women researchers who are following in her footsteps and contributing to our understanding of the opportunities and constraints women face.

As Goldin's work illustrates, removing barriers that may still be keeping women from achieving all they can in terms of their careers benefit firms and our society as a whole. Equal opportunities can lead to greater efficiency in terms of the utilisation of the abilities and skills that both men and women bring to the labour market. Goldin explores why gender gaps persist despite women's gains in education and equal pay legislations that have been introduced in most countries. Her work shows that gender gaps in the labour market are not simply due to individual choices, but rather the result of a complex set of social, economic and cultural factors. Her findings contributed to the development and adoption of specific policies aimed at promoting gender equality. Her research on the impact of childcare costs informed policies such as state-subsidised childcare and paid parental leave. Her research on bias and discrimination in hiring and promotions helped underline the importance

of equal pay legislation, standardised, objective hiring and evaluation practices, and pay transparency laws. Goldin's work also highlights the importance of education and training and of policies that promote gender equality in education. Her recent research outlines the role of the intertemporal flexibility of jobs and substitutability among workers, and the need to rethink traditional expectations of work hours.

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Artificial Intelligence in the Financial Sector – Innovation and Risks*

Anna Domokos  – Péter Sajtos 

Artificial intelligence has come a long way and achieved many breakthroughs. Today, this technology is in the focus of public debate again and is increasingly part of our everyday lives. The financial sector is no exception to this trend. As this technical paper demonstrates, given the risks associated with efficiency-enhancing business opportunities, there may be a case for a possible sector-specific regulatory framework, which is essential to exploit the potential of the technology while minimising the risks.

1. Introduction – historical background

Since its beginnings, artificial intelligence¹ has reached a number of significant milestones. While the field of research dates back to the ‘Artificial Intelligence’ conference at Dartmouth College in 1956 (*Harvard University 2017*), and the first results were published as early as in the 1960s, following the creation of Eliza, the first ‘official’ chatbot system (*Tarnoff 2023*), it did not become popular among the public and was not widely used until several decades later, when ChatGPT became publicly available at the end of 2022, leading to a significant shift in the focus of artificial intelligence solutions.

Looking back over the past 20 years, Google search trends make it clear that the period relevant in this respect is by no means limited to the last 1 to 3 years, both in terms of theoretical research and practical results (*Figure 1*). In particular, the period 2016–2017 can be considered as a breakthrough in the field of deep learning.² During this period, Google published the ‘Attention is all you need’ study of the concept of transformer models, and OpenAI became more widely known among developers. It was also the time when cross-enterprise initiatives to promote the interoperability of solutions were first launched (e.g. with Facebook and Microsoft), and we were introduced to Sophia, the intelligent humanoid robot, and AlphaZero

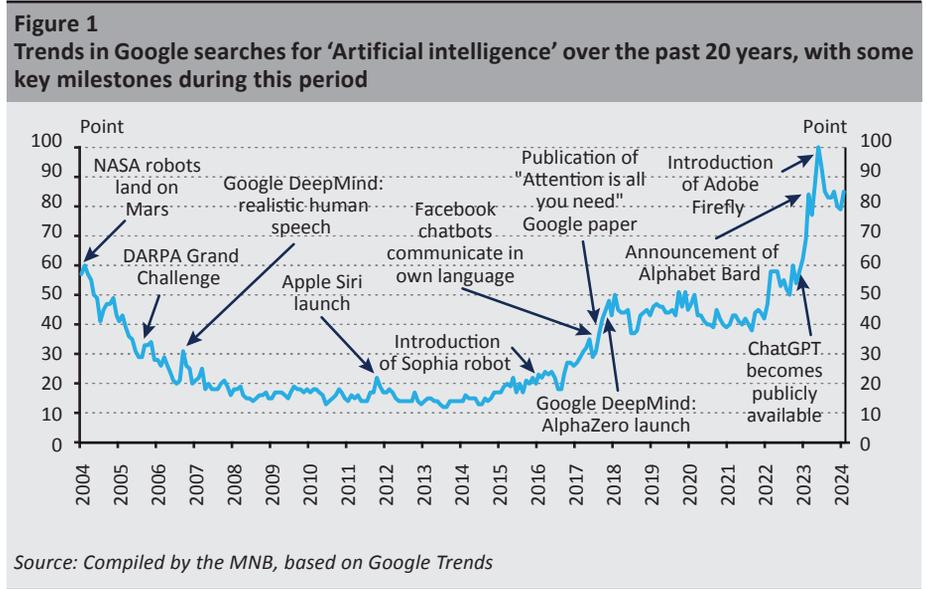
* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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¹ See *Figure 2* for the definitions of each term.

² See *Figure 2* for the definitions of each term.

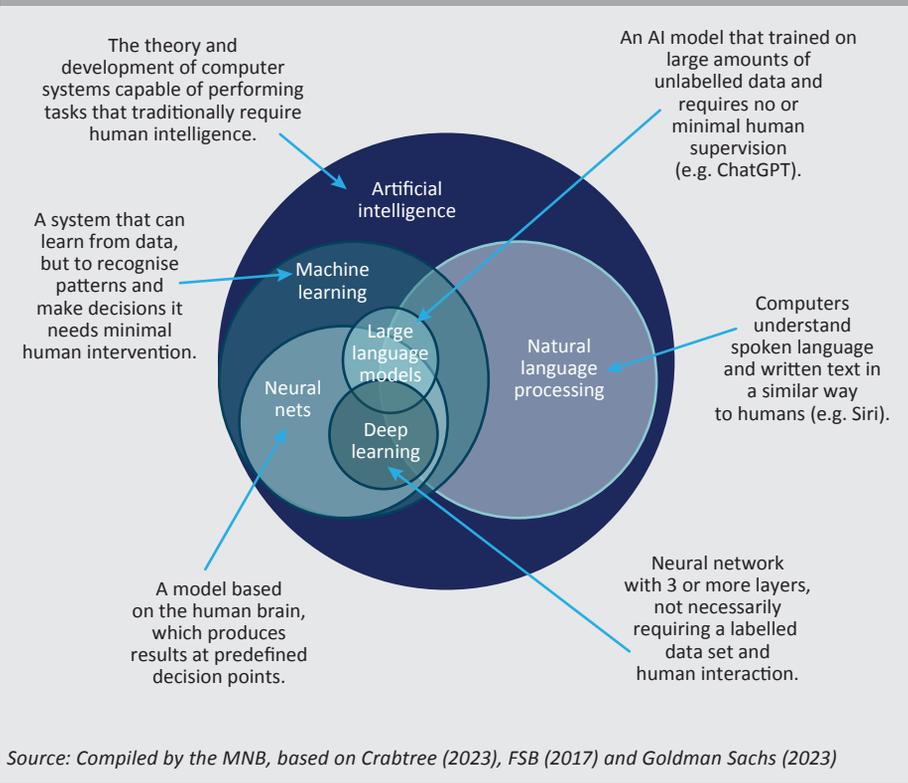
(an enhanced version of Google DeepMind AlphaGo, which was capable of advanced self-learning, including the ability to master chess in a few hours after learning the rules of the game). However, there is no doubt that the emergence of ChatGPT and subsequent research have proven to be a new catalyst in the field of artificial intelligence (Marr 2018; Goldman Sachs 2023; Karjian 2023).



2. The definition of artificial intelligence

The complexity of the technology is demonstrated by the fact that, despite nearly 70 years of scientific research in the field and its presence in our everyday lives, there are still different approaches instead of a single, universally accepted definition of the concept. In short, it is a general concept that refers to the theory and development of computer systems capable of performing tasks that traditionally require human intelligence. That broad approach can thus encompass several operational models (e.g. machine learning, natural language processing, deep learning, etc.). A structured framework of this is presented in *Figure 2*.

Figure 2
Glossary of artificial intelligence



In this area, the definition of artificial intelligence (Russell et al. 2023) and the principles created by the OECD have functioned as the main starting point for both use case research and regulatory efforts in the recent past. However, the OECD definition is only a current consensus, which has been updated several times over the years (2016,³ 2019,⁴ 2023⁵). As the technology evolves, so does its definition, making it difficult to develop an appropriate regulatory framework. However, a common definition is essential for effective communication between the actors involved in the use of the technology (e.g. business users, regulators, technologists). Precisely defining the subject of future legislation relevant to the technology can help to create legislation that supports the safe deployment of artificial intelligence by also promoting trust regarding its use.

³ OECD (2016)

⁴ <https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449>. Downloaded: 9 February 2024.

⁵ Russell et al. (2023)

3. Why can artificial intelligence be important in financial services?

The wave of digitisation-based innovation in recent years has also brought a number of new technological solutions to the financial system. They include mobile payment solutions, for example, whose primary result is making transactions faster and more convenient for customers, while cloud-based solutions mainly help institutions to improve efficiency by modernising data storage and optimising the use of computing capacity. It can be observed that many of the developments that have become established in recent years typically target a smaller part of the financial services value chain, as solutions that affect customers can, for the most part, be separated from those that have a primary impact on internal operations (*MNB 2023*).

Artificial intelligence (AI), on the other hand, may bring about a substantial change, as solutions based on this technology, due in part to the broad and general definition presented earlier, can prove to be relevant at several points of the value chain, and the use cases can cover the entire financial services operating environment (*OECD 2021; Prisznyák 2023*). The use of AI-based solutions can assist more accurate, cheaper and faster decision-making when serving customers (e.g. real-time offers), while also providing advances in automating interactions between institutions and customers (e.g. chatbots) and improving the efficiency of administrative tasks related to specific product application processes (e.g. optical character recognition (OCR) when uploading ID cards) in that context. There are, however, a number of areas in the internal operations of institutions where artificial intelligence can prove to be useful: as an optimisation tool, it may be able to support banks' internal processes related to capital and risk management, thereby improving compliance with operational requirements (*Okwechime 2023*). Moreover, institutions can use more advanced methodologies to estimate or forecast the expected value of key financial indicators⁶ (*Gartner 2022*), and it may also be relevant for the trading strategies related to the portfolios they manage, both in forecasting market movements and effects and in the automated execution of trade transactions.

⁶ E.g. ROE, interest margin

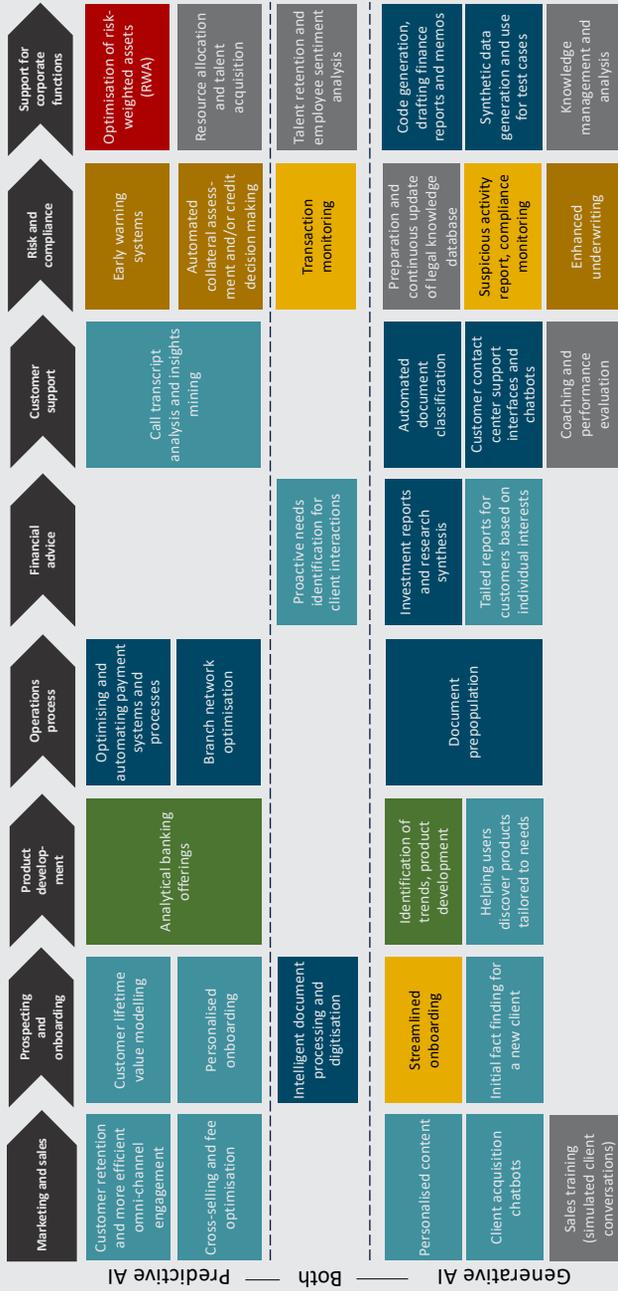
In addition to the above, certain areas of application can also be identified which support both individual institutions and the financial system as a whole. On the one hand, cybersecurity can be improved through the appropriate use of artificial intelligence to develop more effective fraud detection solutions or appropriate automated protection mechanisms, which might also benefit customers. Moreover, AI-based solutions may also increase the efficiency of regulatory compliance and the relationship with supervisory authorities (e.g. automated data transfers).

It should also be emphasised that financial institutions are complex economic entities, which means that various process elements and tasks related to general corporate functions are involved in their operation. This is another area where the sector may benefit from artificial intelligence, whether in order to increase the efficiency of the management of human resources, or in issues that indirectly affect the functioning and competitiveness of institutions, such as image design, optimisation of the territorial distribution of branch networks, or even the design of the internal appearance and layout of branches/customer centres.

It can therefore be seen that the areas of application are rather broad, i.e. financial institutions can find relevant applications for implementing AI-based solutions with predictive and data analytical capabilities, while the creative value creation potential of generative artificial intelligence solutions⁷ can also arise in a number of other aspects (*Figure 3*).

⁷ A type of artificial intelligence systems that generates text, images and other content in response to natural language commands (*Goldman Sachs 2023*).

Figure 3
Key AI-based use cases for commercial banks

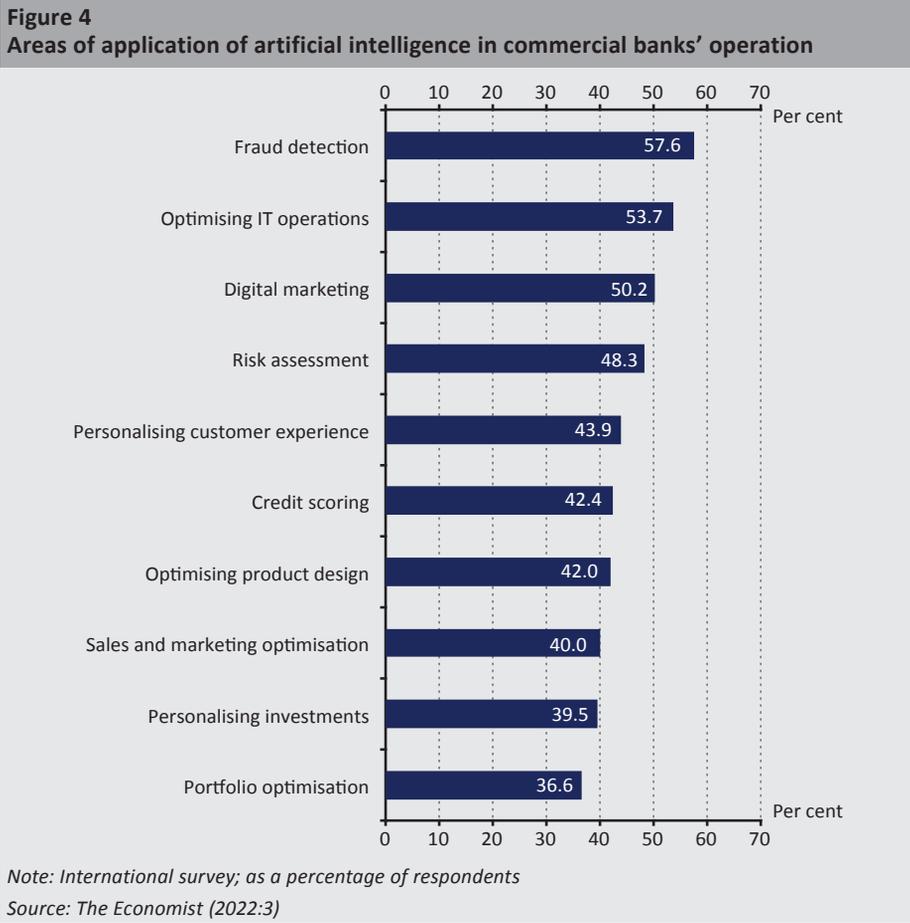


- Enhancing customer intimacy
- Controlling credit risks
- Containing compliance and operational risks
- Providing analytics-based products and services
- Steering and controlling
- Improving operational excellence
- Building workforce and culture

Source: Riemer et al. (2023), Figure 4

4. The uptake of AI-based solutions within the financial system

The financial system’s interest in artificial intelligence began much earlier than the developments seen in the last few years. According to certain studies, the financial system has been among the leaders compared to other industries in the use of artificial intelligence or even more advanced machine learning solutions: according to S&P’s Global 2022 survey, financial institutions had the second-largest market share (18%) in terms of using machine learning solutions, second only to IT and the telecom industry and lagging behind by just a single percentage point (*Fernández 2023*). In recent years, alongside other digitisation developments, banks have implemented a number of AI-based solutions to help them operate with increased security and efficiency (*Figure 4*). However, recent developments and the sudden surge in interest in the technology are expected to further boost the penetration of solutions based on this technology.



5. Potential benefits and risks of the use of artificial intelligence in finance

In reviewing the benefits and risks, it is important to consider the general nature of the technology across the entire financial value chain. While announcements and news regarding the technology typically focus on the impacts on customer-side use, AI-based developments can go far beyond customer-only solutions, as described earlier at the description of possible use cases.

At the same time, as there are a number of potential applications that directly affect customers and their financial behaviour, it is worth first considering the advantages and disadvantages of artificial intelligence from the customer's perspective. The benefits include lower fees and even lower lending costs, making use of the efficient and rapid analytical capabilities of the technology, while a detailed and more accurate analysis of the multiple data sets that can be used (unstructured data, qualitative factors) will make financial services more widely available, as they provide a more comprehensive and accurate picture of a customer's risk profile. At the same time, the use of this technology in the digital space might also open up significant scope for the spread of personalised, custom-tailored financial services and administration, which can improve the customer experience and make managing finances faster and more convenient. From the customer's perspective, however, if the system makes decisions based solely on the data it receives, or if the data used to train the artificial intelligence models is incomplete, inaccurate or insufficient, potential risks such as bias or discrimination in the lending and insurance processes, or the risk of financial exclusion for customers deemed riskier by artificial intelligence, should also be taken into account. In addition, the use of sensitive and personal data also raises ethical questions about the application of the technology to a specific financial decision (*IMF 2021*).

The potential impact of the uptake of AI-based solutions, on both markets as a whole and on individual institutions, may be significant. Artificial intelligence can optimise the functioning of institutions, while providing efficiency gains and a more advanced operating environment, the effects of which, if they are felt by an increasing number of institutions, can benefit the entire financial system, ultimately increasing the competitiveness of the sector as a whole. On the other hand, risks must also be taken into account. The so-called 'black box' effect of complex models and the difficulty of explaining the rationale behind decisions based on artificial intelligence models are often discussed, and dilemmas may arise in that respect in the functioning of institutions, in terms of the demarcation of responsibilities. Moreover, as the technology-relevant expertise and development capacity are typically available from external partners, the dependence on third-party service providers may increase due to the use of AI-based solutions. Given that third-party providers of AI-based solutions may be linked to more than one institution, risk

factors may emerge for the sector as a whole as more of these solutions appear in the financial system or if an AI provider becomes a systemically important actor (as it is an increasing trend in cloud services or mobile payment solutions offered by BigTech companies). Consequently, the problems encountered by the companies that develop these solutions and those that support their operation may have an impact on financial actors. In addition to the above risk factors, cybersecurity and data management are also crucial aspects since, for example, AI-based decision-making typically involves the feeding of sensitive customer data into models (FSB 2017; Bódi et al. 2023).

6. Opportunities to regulate artificial intelligence in the financial sector

We have seen that while the use of AI-based technology solutions is becoming more widespread, they can also pose risks at the level of customers, institutions or even the system as a whole. In addition to developing procedures based on the institutions' own interests and the disciplining power of the market, they can also be addressed through regulatory means. The starting point may be the emergence of a non-sector-specific, comprehensive regulatory approach, such as the EU Artificial Intelligence Regulation, the final provisions of which were subject to political consensus and a provisional agreement between the European Parliament and the Council in December 2023 (European Council 2023) and on 13 March 2024, the European Parliament approved the Artificial Intelligence Act (European Parliament 2024). This is the first legislation on an international level to regulate the use of artificial intelligence systems, along with the 'Blueprint for an AI Bill of Rights'⁸ in the USA. On the other hand, there are also promising international examples of recommendations and principles specific to the financial sector (e.g. in the Netherlands,⁹ Germany,¹⁰ Singapore¹¹ and Hong Kong¹²).

The new capabilities of artificial intelligence, in particular generative artificial intelligence, can enhance or complement human performance in so many ways that the final result of their use is difficult to control or verify by human capacities. Therefore, mapping the potential risks and establishing appropriately applicable principles and regulatory frameworks may also be necessary to avoid potential harm and, in turn, to build trust in the technology (Harkácsi et al. 2021). Given

⁸ <https://www.whitehouse.gov/wp-content/uploads/2022/10/Blueprint-for-an-AI-Bill-of-Rights.pdf>. Downloaded: 9 February 2024.

⁹ De Nederlandsche Bank (DNB) (2019): *General principles for the use of Artificial Intelligence in the financial sector*: <https://www.dnb.nl/media/voffsrc/general-principles-for-the-use-of-artificial-intelligence-in-the-financial-sector.pdf>

¹⁰ Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) (2021): *Big data and artificial intelligence: Principles for the use of algorithms in decision-making processes*. <https://www.bafin.de/ref/19594552>

¹¹ Monetary Authority of Singapore (MAS) (2019): *Principles to Promote Fairness, Ethics, Accountability and Transparency (FEAT) in the Use of Artificial Intelligence and Data Analytics in Singapore's Financial Sector*. <https://www.mas.gov.sg/~media/MAS/News%20and%20Publications/Monographs%20and%20Information%20Papers/FEAT%20Principles%20Final.pdf>

¹² Hong Kong: Hong Kong Monetary Authority (HKMA) (2019): *High-level Principles on Artificial Intelligence*. <https://www.hkma.gov.hk/media/eng/doc/key-information/guidelines-and-circular/2019/20191101e1.pdf>

the comprehensive nature of the technology and the ever-increasing pace of its development, it may be beneficial to establish a sector-specific guideline for domestic financial actors to promote the use of artificial intelligence systems in Hungary, taking into account, among other things, security, ethical decision-making and the maintenance of lawful and prudent data management. A non-binding guideline or recommendation could be an appropriate tool to support initiatives by domestic market players within a flexible framework, for example by setting out a general framework of interpretation and definition, principles for application and evaluation mechanisms. Such a document could even include recommended practices or processes, bearing in mind both the need for prudent and safe use and the need for regulatory flexibility to keep pace with the evolving technology.

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“Respect the past so that you can understand the present and work on the future.”

István Széchenyi

Using Stones to Build Stairs – The Story of the Irish Economic Miracle*

Bence Horák 

This paper sets out to demonstrate how the poor, famine-stricken Irish economy evolved into a global model economy. The reasons behind that dynamic development and growth are still the subject of professional debate. It stands to reason that the opening of the market with solid foundations, an intense inflow of foreign working capital due to exceptional tax breaks, an English-speaking population, the efficient use of additional resources offered by EU accession, the country’s unique geographical location, a highly educated workforce and the solidary inclination of the Irish people have all had a beneficial effect. As a result, what once used to be one of Europe’s poorest countries in the 19th century has become one of the world’s most productive economies since the turn of the millennium.

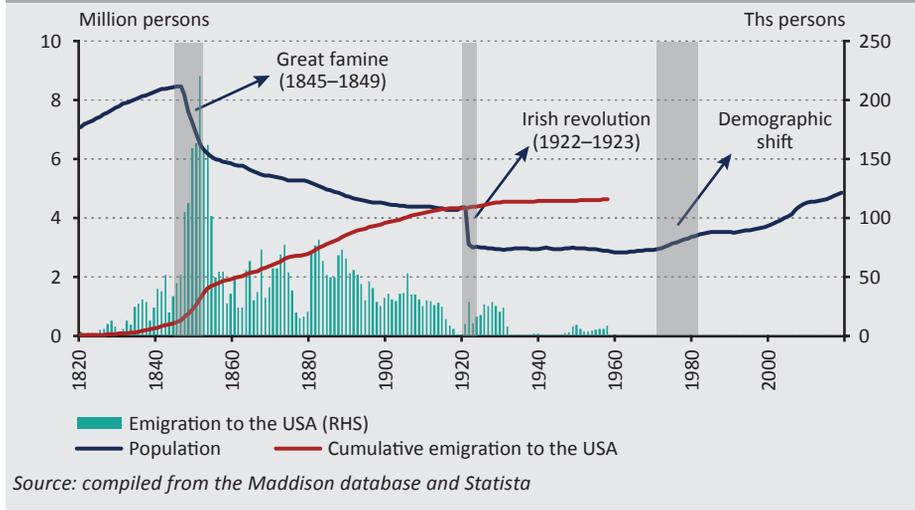
1. Historical background

As a typical Malthusian trap state, throughout the 18th and 19th centuries, Ireland struggled with the dilemma of a growing population and a resulting drop in standards of living. The population of Ireland, a mere 1.9 million in 1700, rose to nearly 8.5 million by the early 1840s. However, the supply of food and raw materials was unable to keep pace with such rapid population growth, which meant that the country was periodically exposed to famines and various epidemics (Ó Gráda 1993). The most serious of these was the crisis known as the ‘potato famine’ or the ‘Great Famine’ of 1845–1849, which led to a massive wave of emigration, mainly to Anglo-Saxon countries (the United States, the United Kingdom and Australia). Somewhat moderated, the westward migration continued throughout the second half of the 19th century and the first half of the 20th century, which was reflected in a decreasing population trend over those decades (Figure 1).

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

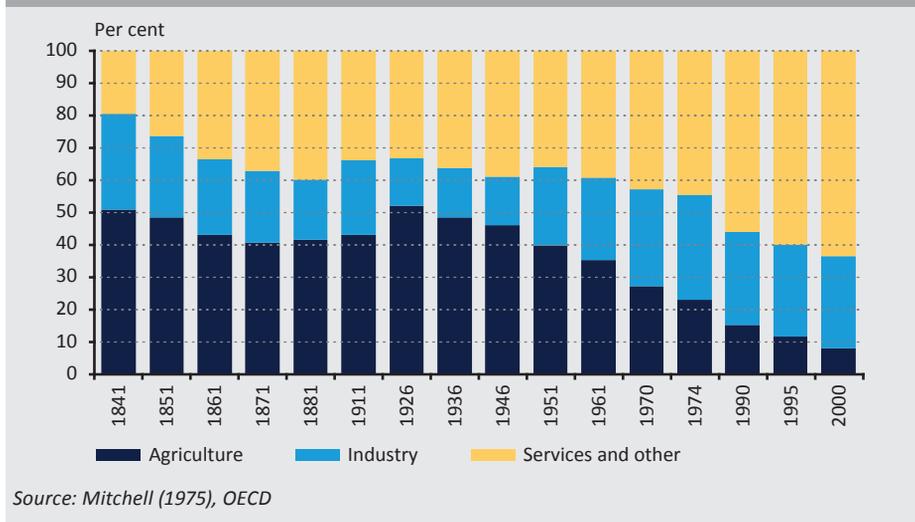
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Figure 1
Population trends in Ireland (1820–2018) and the volume of emigration to the United States (1820–1957)



The early 20th century was characterised by a desire for independence from Great Britain, culminating in the foundation of the Irish Free State by the Anglo-Irish Treaty of 1921 and the Irish Civil War of 1922–1923. At the time of the foundation of the modern Irish state, it was essentially a poor agricultural country in comparison to the countries of Western Europe. In addition to agricultural production in this peripheral country, food and textile businesses, owned by small local Irish companies, also emerged (Figure 2).

Figure 2
Sectoral distribution of employment in Ireland (1841–2000)



Despite having achieved national sovereignty, Ireland was still economically largely dependent on the British economy, with the vast majority (90 per cent) of its exports going to the neighbouring country, while four fifths of its imports originated from there (*Daly 2011*). For the first ten years after gaining independence, the Irish banking system and trade relations were still closely linked to London, and the Irish pound, introduced in 1927, was pegged to the British pound sterling (*Murphy 2000*). However, from the 1930s onwards, protectionist measures, including tariffs, quotas and import bans, were used to strengthen domestic industry (*Ryan 1954*). One of the cornerstones was the *Control of Manufactures Act of 1932*, which declared that domestic companies must be under majority Irish ownership. The Act had a negative impact on foreign capital inflows, and domestic capital also continued to flow outwards without restriction through the investment of Irish banks' deposits abroad and the purchase of British government securities (*Murphy 2000*). The Irish manufacturing industry suffered from a severe shortage of resources, resulting in lower productivity and lower growth in the 1940s and 1950s.

2. The first economic policy shift and its initial effects

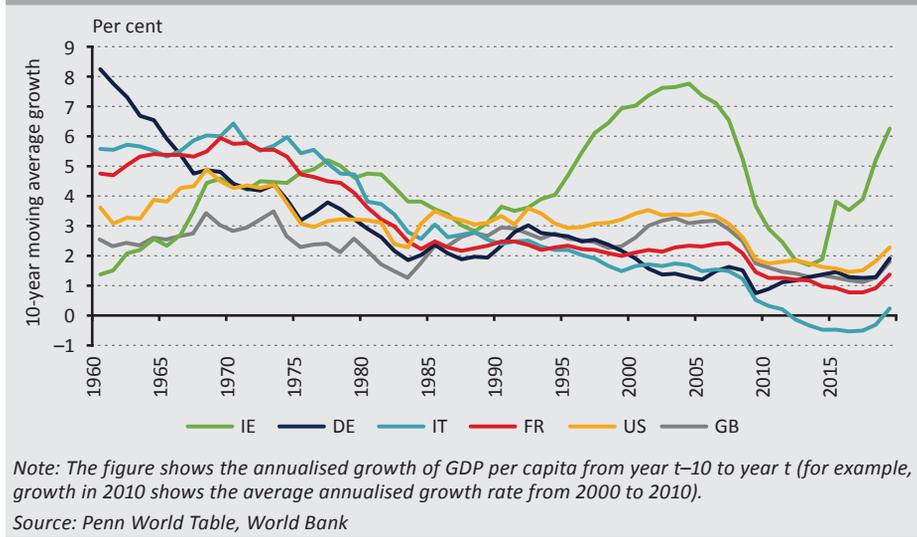
The combined impact of the weight of an agricultural sector generating low added value, the lack of foreign investment and the outflow of domestic capital called for a change in government policies and targeted industrialisation. This process started in 1949 with the establishment of the *Industrial Development Authority (IDA)* to boost domestic industry and attract foreign funds, followed by the establishment of the Irish Export Board in 1952. The next step was the abolition of the *Control of Manufactures Act* in 1957 (*Murphy 2000*), which removed restrictions on foreign investors acquiring ownership of companies in Ireland. In the 1960s and 1970s, with the reform of the corporate tax system, the signing of the 1965 Anglo-Irish Free Trade Area Agreement and Ireland's accession to the European Economic Community (EEC) in 1973, Ireland became effectively integrated into global trade, opening the door to foreign working capital. Ireland joined the European Monetary System (*EMS*) in 1979.

During the first phase, a system of export sales relief (*ESR*) was introduced in 1956. Under a decree, industrial companies selling their goods abroad were first exempted from half of the corporate income tax and, from 1960, they were granted full tax relief (*Walsh – Sanger 2015*). This regime of subsidies remained in place for nearly two decades, laying the foundations for building fast-growing export-oriented sectors in Ireland, particularly in computer software and equipment manufacturing and international financial services. The first modern corporate tax system was introduced in 1976. It included a favourable corporate tax rate of 10 per cent for companies engaged in industrial manufacturing, as opposed to companies specialising in other activities and in particular to the tax burden in Western European economies, where the general tax rate was as high as 50 per cent (*Walsh – Sanger 2015*).

In addition to the establishment of a system of export promotion, the first modern *Special Economic Zone (SEZ)* was set up in 1959 near Shannon airport. The special zone operated on the principle that businesses were granted concessions and exemptions from sales tax on imported goods and goods used for the production of export goods. Corporate taxes were also reduced within the special zone. Moreover, businesses were offered grants to support research and development within the zone (Kennard – Provost 2016).

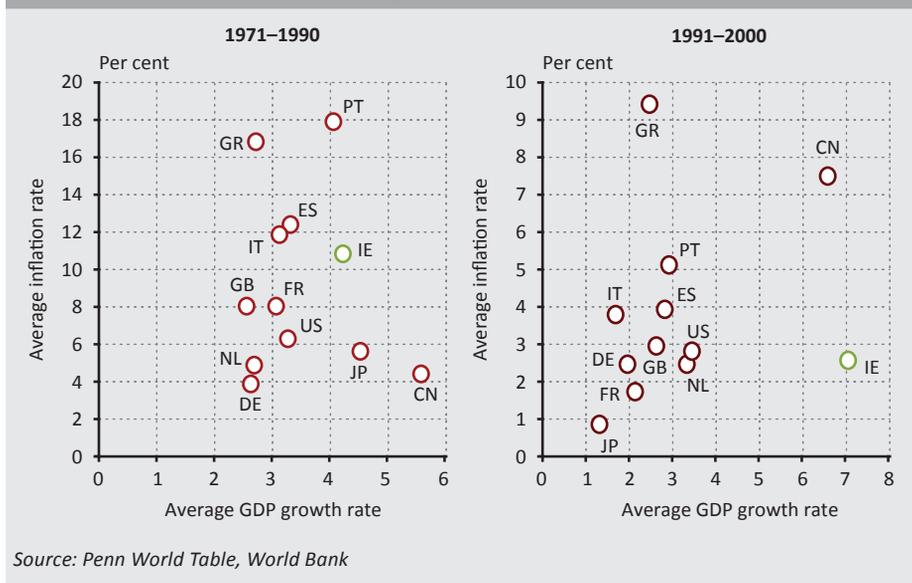
As a result of trade liberalisation and structural transformation of the economy, the dynamics of real GDP growth accelerated from the late 1950s (Figure 3). By 1961, the share of agricultural employment had fallen to 35 per cent from 46 per cent recorded fifteen years earlier. A shift began, initially towards manufacturing and later towards services (Figure 2). FDI inflows reached outstanding levels as a percentage of GDP. Similarly to other developed economies, however, Ireland was adversely affected by the global economic conditions of the 1970s, i.e. the first and second oil price shocks (1973 and 1979). While growth in output slowed down moderately at first, it then fell substantially by the early 1980s. The recession of 1974–1975 called for anti-inflationary economic policies (Simon 2005). While the average annual inflation rate in Ireland was close to 14 per cent during the period 1971–1980, the annual increase in consumer prices was more than 10 per cent even including the following decade (Figure 4).

Figure 3
Real GDP growth dynamics of some advanced European economies and the US, 1960–2019



In the first half of the 1960s, the country’s improving economic situation and the demographic turnaround led to an increase in the population due to a net positive migration balance, a trend that continued until the late 1970s (*Figure 1*). The surplus of immigrants over the period also increased the proportion of working-age people¹ from 57.7 per cent of the total population in 1967 to 59 per cent in 1982 (*UN 2022*). By contrast, however, rising unemployment due to national wage agreements and deteriorating economic stability from the mid-1970s onwards led to very slow growth in employment. By the 1980s, unemployment remained stagnant at a level in excess of 10 per cent (*Aldcroft – Penelis 1993*), which was one of the highest rates compared to developed economies.

Figure 4
Average inflation and average GDP growth in some developed countries

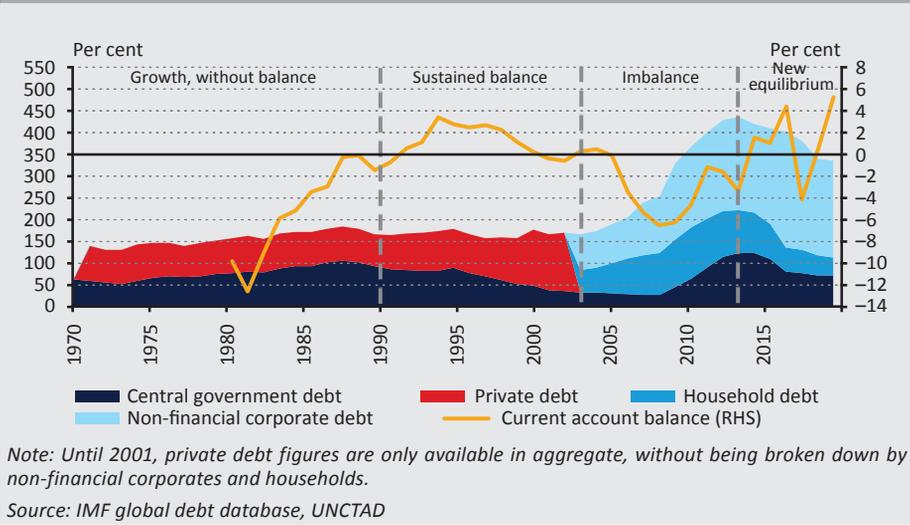


Despite a rising inflow of foreign funds, the economy was still very much reliant on imports. Public spending increased in the first half of the 1980s, with the public deficit amounting to 10.2 per cent of GDP by 1986. The current account deficit averaged more than 10 per cent of GDP between 1980 and 1982, only reaching a balanced position by the middle of the decade. The evolution of the Irish current account can be broken down to several phases during the period under review (*Figure 5*). Adjustments were carried out by the central government at the expense of debt financing, which resulted in central government debt jumping from 52.1 per cent of GDP in 1973 to 104.7 per cent in 1987 (*Figure 5*). The Irish coalition

¹ People aged 15–64

government was unable to respond to the problem with sufficient speed and effectiveness, and the impact of deficit reduction measures only began to be felt from 1987 (Murphy 2000). There was a need for economic stabilisation and a new strategic direction, which the government started to develop in 1987.

Figure 5
Central government debt, private debt and current account developments
as a percentage of GDP, 1970–2018



3. The Irish stabilisation programme and a decade of economic miracle

The 1990s and the first years of the following decade ushered in the period of the ‘Irish economic miracle’ on the island. Economists studying the conditions of intense economic growth and development were divided into two major camps. Some contended that the pivotal factors were the stabilisation programme launched by the Irish government between 1987 and 1993, the symbiotic attitude of the society as a whole and the geographical location of the country, while others emphasised the outstanding significance of Expansionary Fiscal Contraction (EFC) as a textbook example of good government policy. In fact, both of the above factors probably had a significant effect.

According to those supporting the EFC view, the fiscal consolidation of the 1980s triggered significant economic activity in the private sector. This implies that the impact of credible fiscal tightening measures was embedded in the private sector’s future expectations of taxes and government spending, ultimately inducing much stronger aggregate consumption and investment in the present and leading to

higher economic growth. The economists who subscribe to this theory look to the EFC as the main indicator of development, and have used the failed stabilisation period of 1982–1984 and the positive economic turnaround of 1987–1990 to support their argument. In their analysis, they pointed out that both periods featured similar external conditions due to strong export activity and a downward interest rate bias stemming from a commitment to exchange rate stability, but the outcomes were diametrically opposed (*Giavazzi – Pagano 1990*).

In addition to the fiscal adjustment to boost growth, however, a number of other factors may have contributed to the surge. These include the economic stabilisation programme launched between 1987 and 1993 and the liberalisation efforts (such as the abolition of internal tariff barriers) undertaken in previous decades, which led to an inflow of working capital from the US and, following accession to the EEC, from Western Europe. Another important milestone was the creation of the *International Financial Services Centre (IFSC)* in Dublin in 1987, which, as a centre for the financial and insurance sector within the European Union (*Bourke – Kinsella 2001*), has played a key role in financing technological investment by Irish firms and attracting capital from offshore financial companies to Ireland.

Moreover, the overall social consensus among the Irish and the institutions of the central subsystem may also have played a major role in that dynamic convergence. Two social partnership programmes were launched during the period to improve the international perception of the Irish economy, reduce internal inequalities and strengthen social consensus. The *Programme for National Recovery (1987–1990)* and the *Programme for Economic and Social Progress (1991–1993)* focused primarily on wage agreements, tax reforms and sectoral objectives (*Simon 2005*). The combined effect of social initiatives and economic policy restructuring was at least as important as the opening up of trade during the 1960s.

Since the late 1980s, the recapitalisation of the private sector and efficient privatisation have replaced the subsidising of state-owned enterprises among the government's chief priorities. As a result, the share of public sector employment has fallen from 8 per cent to below 3 per cent over two decades. Market liberalisation has been achieved through highly conscious government measures, the cornerstone of which has been the further improvement of investment conditions, as well as a comprehensive education reform resulting in the modernisation of all levels of education from primary to adult education. The increase in capital intensity in both areas has largely been the result of the efficient use of EU funds (*Simon 2005*).

In addition to improving the skills of the domestic workforce, they have been relying on the incubator concept to strengthen economic restructuring. Incubators were initially set up around universities to promote technology transfer and innovative

research, as well as to encourage entrepreneurship (*McAdam – McAdam 2006*). EU funds have been used to support processes of change. Moreover, the government has implemented an intensive investment drive to improve the profitability of production by foreign companies in Ireland. One key to that change has been the flow of resources from low productivity and high labour-intensive sectors to higher productivity and low labour-intensive sectors. The share of agriculture and domestic industrial production in the national economy has declined, despite the fact that foreign ownership of industrial enterprises was a mere 15 per cent in 1993 (*Nagy 2000*). At the same time, the contribution to the national economy of non-domestic companies has been rising steadily, especially in the more productive sub-sectors of manufacturing. In 1983, foreign firms accounted for nearly 60 per cent of output and nearly 40 per cent of employment, which rose to 82 per cent and 47 per cent respectively by 1998. The two leading sectors were chemicals and machinery, between them accounting for nearly two thirds of value added in the sector and more than half of employment at the turn of the millennium (*Simon 2005*).

Alongside manufacturing, the IT sector, which is one of the most productive industries, had become Ireland's other leading sector by the second half of the 1990s. During that decade, a number of US high-tech companies (e.g. Intel, Google and Microsoft) opened branch offices in Ireland. In addition to the Irish government reducing corporate tax rates (*Figure 6*) and recapitalising and upgrading the technology of Irish subcontractors working with foreign companies, the presence of a well-educated, English-speaking workforce and an influx of skilled human capital from English-speaking countries and continental Europe helped attract those companies to Ireland (*Figure 8*). Moreover, the country's R&D investment increased from 0.7 per cent of GDP in 1981 to 1.3 per cent in 1994, jumping from two fifths to three fifths of the EU average. This was achieved in the face of a trend of foreign technology companies keeping a significant part of their research activities in their home countries. In 1999, approximately three quarters of R&D resources were spent on innovation in the business sector, while one fifth was received by higher education institutions (*Simon 2005*).

Figure 6
Corporate tax rate and tax on the net profit of companies, 1981–2020



The export-oriented economic policies started in previous years have been maintained. Foreign direct investment (FDI) as a share of GDP reached increasingly high levels by the late 1990s. Coupled with dynamic output growth, this resulted in an almost unprecedented inflow of foreign capital. In less than two decades, a massive influx of FDI transformed Ireland into a modern, high-tech economy. Foreign trade was mostly conducted with industrialised and developed countries. While exports to the United States more than tripled, the share of Japan and developing Asian countries also increased severalfold, resulting in a gradual shift in foreign trade away from the United Kingdom.² The country reinforced its position as a net exporter. Considering goods and services combined, each calendar year in the 1990s ended with an export surplus, by more than an annual 10 per cent of GDP on average. As the pound sterling depreciated significantly during the British ‘Black Wednesday’, i.e. the ERM crisis in September 1992, Ireland temporarily lost its favourable export position vis-à-vis the UK economy. As a consequence, the Irish pound was devalued by 10.5 per cent in February 1993 (*Barcza 2001*), which had an additional multiplier effect on the country’s advantageous global trading position.

² *Direction of Trade Statistics (DOTS), Exports and Imports by Areas and Countries*. IMF. <https://data.imf.org/?sk=9d6028d4f14a464ca2f259b2cd424b85>

The Irish government recognised the evolving needs of the market for education and specialised human capital development very early on, in the late 1980s. From the mid-1990s, higher education was made free across the board. In academic institutions, engineering and IT courses have been heavily supported through the Industrial Development Agency of Ireland (*Burnham 2003*). By 1996, the share of science and technology graduates among people aged 25–34 was the highest in the OECD countries. The share of people with a secondary school or vocational qualification in the same age group was 66 per cent, as opposed to 30 per cent of those aged 55–64. Of the total workforce, 20 per cent held a university degree in 1991, which grew to over 30 per cent by 2001. Today, Ireland has one of the highest proportions of people with a higher-education degree within the total population aged 25–34 and 55–64, which represent nearly two thirds of the population.³ The PISA test database, which has been available since 2000, shows that Irish students' reading scores were above the OECD average in every year and that, out of the seven tests, the maths scores of 15-year-old students were also above the OECD average in all but one year.⁴

In the 1990s, Ireland achieved unique growth, at a rate previously only observed in East Asia. While average GDP growth in developed countries was decelerating immediately before the turn of the millennium, the Irish growth rate continued to increase rapidly (*Figure 3*). Annual average GDP per capita growth exceeded 7.5 per cent over the decade. During this period, central government debt declined from 86.3 per cent in 1990 to 32.6 per cent in 2002 and the current account balance was in surplus from 1991 to 1999 (*Figure 5*), while the average level of inflation dropped to 2.6 per cent between 1991 and 2000 (*Figure 4*). Moreover, with a permanent reduction in the corporate tax rate, budgetary revenues from corporate income tax continued to increase with each year, both as a share of GDP and as a share of total taxation (*Figure 6*).

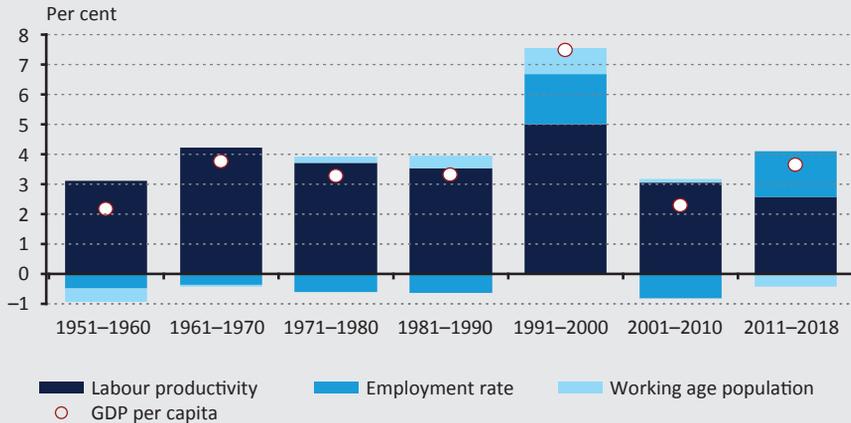
A number of factors contributed to the surge in GDP per capita growth in the 1990s, but it is worth noting that Ireland benefited greatly from the demographic dividend of the period. The period was characterised by higher real wage growth compared to advanced economies, accompanied by an improvement in infrastructure and living standards. Labour productivity rose sharply, driven by a large inflow of physical capital and high levels of productivity following the structural transformation of the economy. Net positive migration increased the share of the working-age population and the employment rate rose with the gradual decline in unemployment (*Figure 7*). In a 'growth accounting' framework based on *Solow (1956)* and his model extended by *Mankiw – Romer – Weil (1992)*, Ireland's dynamic growth over the decade could

³ *Population with tertiary education (indicator)*. OECD. <https://doi.org/10.1787/0b8f90e9-en>. Downloaded: 28 December 2023.

⁴ For detailed data and results of the PISA tests issued in a given year, visit <https://www.oecd.org/pisa/test/>.

hypothetically be interpreted as the combined result of quantitative factors (growth in employment and the share of working age population) and qualitative factors (education) of human capital, strong capital inflows and the productivity boom, in contrast to earlier periods.

Figure 7
Decomposition of real GDP growth per capita in Ireland by decade (1950–2018)

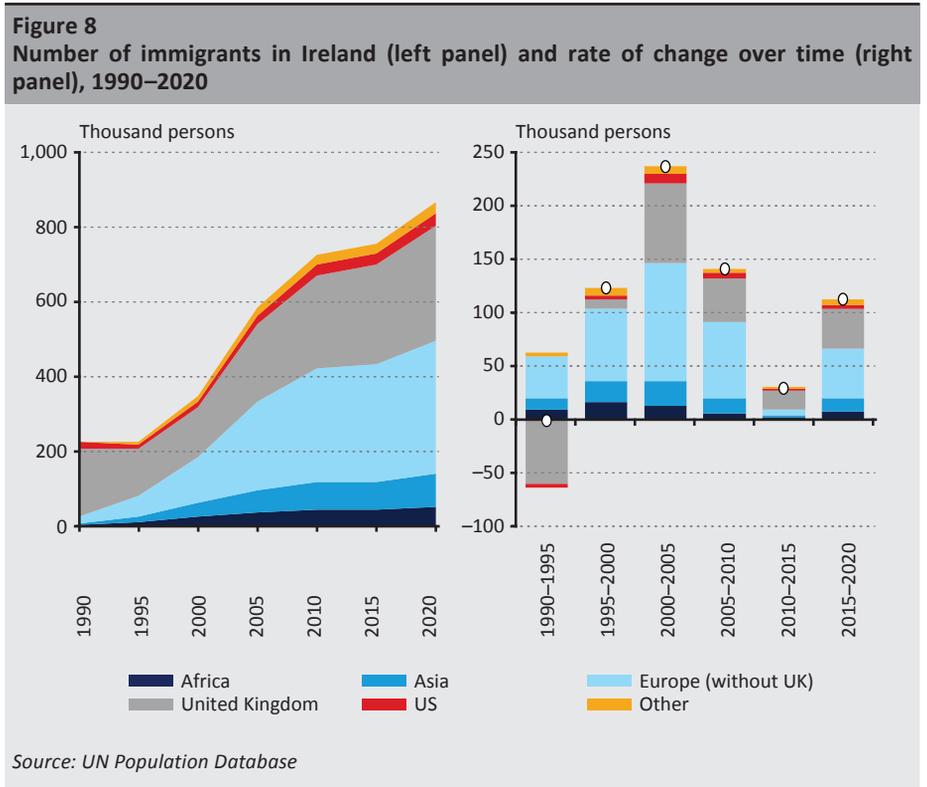


Source: calculated on the basis of the OECD, Penn World Table and Maddison database

The government also capitalised on the potential of the Irish diaspora that had developed organically in developed economies, particularly by revitalising links with communities in the United States. According to some surveys, more than 30 million people in the US, several times the population of Ireland, are of Irish descent. Prior to the 1990s, government support for young Irish people to go overseas to gain experience was seen as a bad thing. After the economic policy shift, however, a boomerang effect developed (*Smith 2023*), in which Irish companies and foreign companies, mainly from English-speaking countries, operating in Ireland were benefiting from a more highly qualified workforce. Irish expatriates induced a buoyant inflow of capital, concentrated in the engineering, tourism and financial services sectors, and particularly in the computing and technology industries, where Ireland has been something of a bridge between Europe and Silicon Valley, as *Stensrud (2016)* put it.

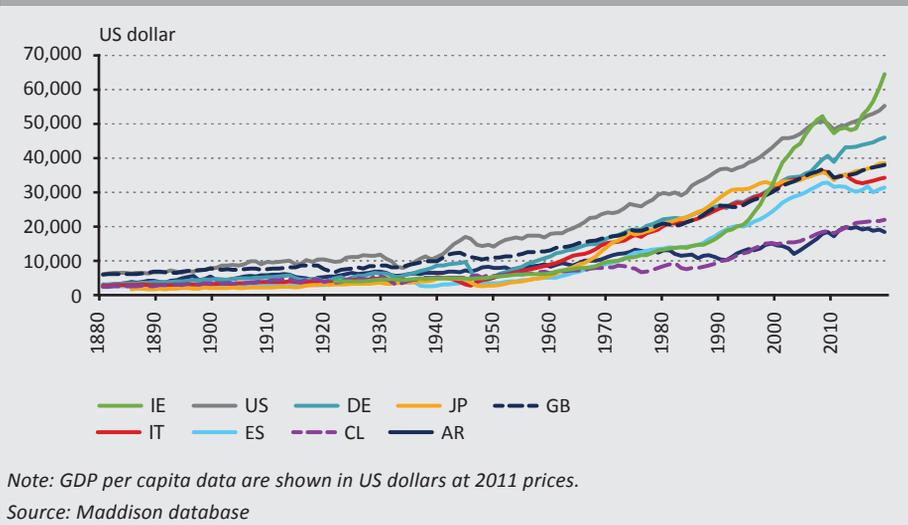
Moreover, net population movements exceeded 200,000 between 1992 and 2003. The majority of immigrants were qualified working-age people, mainly from English-speaking countries and continental Europe (*Figure 8*). Population growth was also greatly influenced by the number of Irish citizens returning home from the UK and the US. Between 1990 and 2005, the Irish population decreased by 150,000 in the

UK and by nearly 25,000 in the US. Population growth was therefore driven by people of Irish nationality and with Irish roots returning from developed, mainly English-speaking countries, and the arrival of skilled, working-age immigrants from continental Europe (mainly from Eastern and East-Central Europe) (UN 2022).



As a result of the trends that occurred in the 1990s, Ireland’s real GDP per capita outstripped per capita real GDP in other Western European economies after the turn of the millennium and, 15 years later, it surpassed that of the United States (Figure 9), becoming a benchmark economy for catching up for (semi-)peripheral EU member states.

Figure 9
Trends in real GDP per capita in some countries, 1880–2018



4. Conclusion

Today, Ireland is a global leader in several innovative industries. Its population is growing year after year, and it is among the world’s elite in terms of a significant number of key economic and development indicators. This is a highly unique phenomenon for a small and open economy, which could serve as an interesting model for economic policy-makers to adapt in their home countries.

However, it is also clear that the formula is extremely complex, as only a few economies in the world are at the starting point or possess the endowments Ireland had in the first place: a history of Anglo-Saxon industrialisation and infrastructure development, English as the country’s native language, a disciplined society with traditions, demographic dividends and relatively early integration into the European economy. Nevertheless, some of the pillars of the Irish economic policy strategy include elements that can be adapted in other countries to generate both intensive and extensive growth in a given period of economic development.

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Deglobalization, inequality, and the green economy*

Peter Sanfey 

Fikret Čaušević:

Deglobalization, financial inequality, and the green economy

Routledge, 2023, p. 162

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Fikret Čaušević has written a fascinating and timely book on deglobalization, financial inequality and the green economy. The author, whom I am privileged to call a long-standing friend, is Professor of Economics and Finance at the University of Sarajevo and is well-known as a leading authority on his native Bosnia and Herzegovina and the Western Balkan region. But his current volume is truly global in nature. Čaušević draws on a wide range of cross-country macroeconomic datasets, covering almost all parts of the world to support his arguments. The result is a book that is both concise and readable, but also thought-provoking and even shocking at times when global disparities and inequalities are laid out so starkly.

Many of the findings the author presents are both familiar and at the same time jaw-dropping. Some examples illustrate the point. We all know China's foreign reserves have grown dramatically in the current century, but I was still amazed to see that they had risen from US\$ 166 billion in 2000 to US\$ 3.84 trillion in mid-2014, an increase of much more than twenty-fold. Or look at the disparity across countries in assets: they average just US\$ 173 per capita in the bottom decile of countries (in 2020) versus more than US\$ 2.2 million in the top decile. And when it comes to GDP per capita, it is useful to be reminded that, even after several decades of rapid growth in many developing countries, the GDP per capita of the top decile countries is greater than the bottom decile by a factor of 119.

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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The views in this review are those of the author only and not of the European Bank for Reconstruction and Development (EBRD).

Čaušević's book consists of six chapters. In this review, I briefly summarise the main contribution of each chapter and add my thoughts on what I see as the most important insights, including, in some cases, areas where the arguments could be modified or extended in future work.

Chapter 1 contains a brief introduction and a short, selective overview of the literature on globalization and financial inequality since the start of the current century. Much of the discussion covers familiar ground, of course: the collapse of the dotcom bubble in 2000, the continued rise in globalization in the first decade until the global financial crisis and the inevitable rethink of globalization in the aftermath. I found most useful the discussion of recent books and papers on the imperfections on global capital flows and the pervasive role of tax havens. The difference between “real” and “phantom” FDI, to use the distinction made by *Damgaard and co-authors*¹, is one that I think should be given more prominence. FDI is often viewed uncritically as a “good” thing, but this makes no sense if much of it is simply based on an artificial registration of legal entities in a foreign jurisdiction in order to avoid taxes.

Chapter 2 is where we start to get to the meat of the book by taking a first look at the raw data on GDP across the globe and how it has evolved across countries in the current century. Čaušević adopts a simple but instructive approach, namely, to look at the evolution of the ratio between a country's GDP per capita and the world average of GDP per capita. I was surprised to see that the top 50 countries in terms of GDP per capita growth in the first decade of this century were all emerging and developing countries. A similar pattern is evident in the second decade. Despite this, at the end of 2020 economic inequality seems more or less unchanged from the level in 2010. I would have liked to see some further discussion of this result in this chapter. Much of the discussion focuses on the most advanced countries and the differences among them during this period in terms of variables such as net capital imports, credit to the non-financial sector (CNFS) and public debt. I was not entirely convinced by the arguments here. For example, a rise in the ratio of CNFS to GDP is seen as a bad thing for countries with very weak GDP performance like Greece or Italy, but it is also noted that this indicator shot up in China between 2010 and 2020, alongside the country being the second-fastest growing economy worldwide between 2010 and 2020. The chapter concludes with a useful discussion of the energy transition and the distribution across countries of important natural resources.

¹ <https://www.imf.org/en/Publications/fandd/issues/2019/09/the-rise-of-phantom-FDI-in-tax-havens-damgaard>

Chapter 3 delves into global financial assets and liabilities. Again, I found it very useful to see the data laid out in simple, even stark terms. Čaušević shows how Europe retains a dominant role in assets and liabilities, with more than 50 per cent of both, although this has fallen a few percentage points since 2010. He then reiterates the point from the previous chapter about the importance of looking at data on credit and net imports of capital. A link is drawn with Post-Keynesian economic theory, but the point is not really developed and could perhaps have been omitted in what is really a short, data-driven chapter.

Chapter 4 contains the main thrust of the whole book, linking GDP growth with changes in financial and environmental variables. Čaušević draws on a database provided by the Bank for International Settlements covering 43 countries and combines it with World Bank data on GDP. In essence, the idea is to weight GDP growth rates by a measure of financial efficiency (or by environmental sustainability later in the chapter) and compare countries in each of the two decades of the current century, as well as the whole 20-year period. The assumption underlying the analysis is that countries are performing “better” than others if they can combine high economic growth with only limited rises in credit and preferably net exports rather than imports of capital. Israel, for example, is singled out as a country that combined strong GDP growth between 2000 and 2020 with virtually no change in its CNFS/GDP ratio and a major shift from a net capital importer in 2000 to net capital exporter in 2020. Contrast this with the case of France, which combined anaemic growth over the past two decades with a shift from being a net capital exporter in 2000 to being the third largest net capital importer in 2020. I believe this is a novel and illuminating way of looking at data on GDP and financial asset flows, but I would caution about reading too much into these patterns. Ranking countries’ economic performance in global tables is a complex task and cannot be captured by a single metric. The same point applies to the latter part of the chapter, when growth rates are weighted instead by greenhouse gas emissions. Again, the rankings are informative, but do not necessarily give the full picture on which countries are performing best in their efforts to develop renewable energy and combat climate change.

Chapters 5 and 6 are more discursive and less data-driven than the previous chapters. I enjoyed both chapters nonetheless, particularly the latter one on Fintech which contains a very nice overview of recent contributions in this often-confusing field. I particularly liked the reference to *Eichengreen’s “trilemma”* – namely, the impossibility of simultaneously satisfying the goals of introducing a digital currency, maintaining the confidentiality requirement in transactions, and achieving financial stability. This is a lesson that needs wider acceptance in my view, in light of the often very frothy discussion of the potential of such innovations.

In summary, I very much hope this book attracts a wide readership. It is short, easy to read even for non-specialists and full of interesting insights and data patterns. One does not have to agree with all of the author's conclusions to benefit from reading this volume and using it as a platform for further research and investigations into the great economic and financial trends and challenges facing policy-makers around the globe.

Round Table Discussion: Lessons from the 1970s – Inflation and Monetary Policy in Focus*

Márton Zsolt Nagy 

On 5 October 2023, the Finance Section of the Hungarian Economic Association organised an online roundtable discussion with the title “*What can we learn from the past (essentially from the 1970s) concerning the current challenges linked to inflation, monetary policy and the banking sector?*”. The organisers wished to highlight the importance of recalling economic history and historical experience when examining issues regarding inflation. The event was moderated by *Pál Péter Kolozsi*, President of the Finance Section of the Hungarian Economic Association, Director at the Magyar Nemzeti Bank (central bank of Hungary, MNB) and Associate Professor at the MNB Knowledge Centre of Neumann János University. After the opening address by *Barnabás Virág*, Deputy-Governor of the Magyar Nemzeti Bank responsible for Monetary Policy, Financial Stability and International Relations, presentations were delivered on the results of two foreign and two Hungarian research projects, describing the lessons and experiences of major inflationary episodes in the past fifty years in the light of the contemporary analysis of inflation.

In his opening address, Virág stressed the particular importance of economic history. This was especially true today, when standard analytical frameworks and traditional models were unable to provide a comprehensive explanation for nonlinear events. “It is through the lens of history that we can discern structural changes, trends and patterns from the different areas,” he said. New economic models also need to show consistency with past events before they could be considered as sound economic principles. Although there was no historical precedent that provided a perfect analogy for the present situation, drawing parallels could lead to ideas that facilitate coordination and help to answer the questions that may arise. Insights into methodological pluralism and an understanding of long-term economic processes also contributed. While the extension of analyses from short to historical scales and qualitative methodologies did not replace the theoretical and empirical models already in use, it could complement them, allowing decision-making to be based on a broader base and more in-depth information. Recognising relevant historical

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patterns on issues such as the impact of the level of indebtedness, identifying the determinants of the nature of inflation or assessing the effectiveness of growth models was essential to ensure that monetary policy can respond quickly and adequately to the challenges ahead in a turbulent decade such as the 2020s.

The first presentation was given by *Laurent Ferrara*, Professor at SKEMA Business School, with the title “*The determinants of inflation: Lessons from past oil price shocks*” focusing on the experience of developed countries. Professor Ferrara attributed the emergence of the current inflation environment to the imbalance between household demand for consumer goods and the relative shortfall in supply during the pandemic, and to the impact of the Russian-Ukrainian war in 2022 on the price increases observed in industrial and agricultural goods and energy. In his presentation, he sought to answer questions about how central banks should respond to shocks in the price of strategic commodities such as oil. Should central banks raise interest rates in response to oil price shocks, and if so, by how much and for how long? By presenting the literature on the relationship between oil price shocks, interest rate hikes and recessions in the United States of America, he highlighted the potential non-intuitive effects of central bank measures.

The literature draws attention to the role of monetary tightening in response to negative supply shocks in amplifying recessions, the different effects of the various factors that trigger shocks and the questionable effectiveness of policy interventions. The theory argues that the oil price shocks in the USA were followed by recessions, and that central banks may have amplified this process by raising interest rates, which spread the impact of oil price shocks across the economy. A distinction could be made between supply shocks, aggregate demand shocks and the impact of news on global oil prices. While supply developments in general did not play a role in driving oil prices, aggregate demand shocks occurred with a three-quarter lag, while news shocks had an immediate impact. Academics have called into question the effectiveness of monetary tightening in response to such shocks: when comparing oil price shocks during normal periods and zero lower bound periods, the role of interest rate hikes in lowering the consumer price index and anchoring inflation expectations could not be isolated, whereas rate increases might have a negative impact on GDP developments. In other words, an interest rate hike following the oil price shock may have a negative impact on the economy without contributing to normalisation. Ferrara was therefore concerned that the Fed, the ECB, the Bank of England and the Bank of Japan had raised key policy rates rapidly and sharply to levels that pre-date the global economic crisis of 2008 in response to, *inter alia*, inflationary pressures from excess demand and geopolitical tensions in 2022. Accordingly, he stressed that it is crucial to be aware of the nature of the price shocks at the moment when policy interventions are introduced. In the case of news shocks, this could be achieved by *text mining* and *natural language*

processing models, while the co-movement of commodity prices could be used to identify supply-demand imbalances. Ferrara and his co-researchers found that the co-movement of commodity prices pointed to an aggregate demand shock, while the absence of such a co-movement indicated a supply shock.

The presentation by *Eric Monnet*, a professor at the Paris School of Economics, was entitled “*Do disinflationary measures distort central bank performance? Lessons from the 70s and 80s*”. In his presentation, Professor Monnet sought to answer the question whether central bank losses were a necessary corollary of disinflationary monetary policy. In some countries where central bank losses had occurred, political discourse was generated around the phenomenon, and it was therefore important to answer the question of whether the losses incurred by central banks during their operation were problematic for monetary policy or for the credibility of the central banks concerned. His research found that, despite the disinflation environment, central banks’ capability of making a profit in the 1980s surpassed that of the 1970s. Since this phenomenon was contradictory to what we see today, a loss incurred due to disinflation was not predetermined; however, it was important to highlight the differences between the composition of central bank balance sheets today and in the past. Monnet cited the remuneration of reserves and the legacy of past interventions in central bank balance sheets as the two main differences, referring to the importance of the stock of securities accumulated in a low yield environment. However, he also pointed out that the remuneration of the reserve requirement alone would not lead to losses, but the occurrence of the two phenomena together would. Although central bank losses were also incurred in the 1970s, these were foreign exchange losses on foreign currency reserves due to depreciation of the US dollar. However, the losses on foreign exchange reserves were only due to revaluation and were not realised. Today, the most important sources of central bank losses were the delinquency of securities held as central bank assets, the sale of central bank assets below market prices, and the difference between the interest paid on central bank instruments and the yield on the securities held as assets.

Monnet pointed out that during the Volcker shock, central banks did not realise losses because they did not sell their assets. The ratio of central bank balance sheet totals to GDP increased by 15 percentage points in the 1980s, reaching 20 per cent of GDP by the end of the decade. It was important to see the reasons behind why any central bank suffers a loss. Just as in the 1970s, when the need to hold reserves was not challenged even after depreciation of foreign exchange reserves, it should be stressed today that the current losses resulted, in part, from past central bank measures. Discussions were already under way on changes in the rationale behind interest-bearing required reserves and in the medium term as the interest rates paid on central bank instruments were expected to normalise, and accordingly, it may well be possible to avoid such losses altogether. In summary, the current

and past losses were caused by different factors, and just as in the past when the independence of and confidence in central banks was not called into question after the losses incurred on foreign exchange reserves, there was a need today to coordinate policy instruments and objectives, and to justify and communicate the necessity of the activities that caused the losses, according to Monnet.

Kristóf Lehmann, Director at the Magyar Nemzeti Bank and Head of the Knowledge Centre for Sustainable Finance at Neumann János University, delivered a presentation on *“Inflation similarities and differences between the 1970s and nowadays”*. One common feature of both periods was that they were fueled by geopolitical tensions. In the 1970s, war-related sanctions prompted OPEC countries to cartelise, while the presence of sanctions and the popularity of protectionism was making a mark on global trade again today. That said, in addition to geopolitical factors, the pandemic also had an impact on the price of consumer goods and commodities, with energy prices rising in 2021 at rates approaching those seen in the 1970s.

The two decades differed in several important respects, however, such as the composition of the global economy and global trade and the direction of capital flows. While in the 1970s, developed countries were characterised by an increase in the share of the working-age population, the opposite was true today as part of a long-term trend. In the past, the level of trade union membership was two and a half times higher than today, and accordingly, as the role of trade unions has faded, their bargaining power has deteriorated, and the emergence of a wage-price spiral similar to that of the 1970s appears less likely. The decline in energy consumption per unit of real GDP was welcomed in terms of exposure to energy prices; in addition, the pricing power of OPEC countries was not as formidable as it was in the 1970s. Increased shale oil production and the accumulation of strategic oil reserves had contributed to this as well. However, it was already evident at the time that price caps were most likely to be effective in the short run, and thus they should be applied only temporarily because, as pointed out in the presentation, they would become persistently costly over the long term.

One of the most important conclusions to be drawn from the examples of the 1970s is that in countries where crisis management was successful, there was a strong commitment to intervention and coordination was in place between monetary and fiscal policy instruments. This characterised the economic policy in the Federal Republic of Germany, where there was no double-digit inflation. In the United States, however, economic policy efforts in the 1970s focused on breaking the wage-price spiral. The real change only came about with Paul Volcker and his positive real interest rate policy in the 1980s. In the United Kingdom, the fiscal stimulus in collaboration with deflationary monetary policy pushed the consumer price index up to 25 per cent, while in Japan, inflation peaked on the back of the interest rate

cuts resulting from exchange rate pegging agreements. It is also worth noting the differences in trends in demography and real wages, and in the indebtedness of the public and private sectors.

Balázs Spéder, Head of the Economic History and Theory Department of the Magyar Nemzeti Bank presented the results of a study entitled “*Inflation shocks and disinflation: Stylised facts from the past 50 years*”. In his presentation, he sought answers to a number of questions: whether the inflationary pressures of recent years were temporary or would lead to persistent inflation; whether it was possible to generalise and establish stylised facts about the four inflation shocks observed since the early 1970s; what conditions were necessary for fast-paced disinflation after a strong inflation shock; what were the real effects of disinflation, and what was the role of central banks in defining the growth rate that may be potentially traded off? To answer these questions, the authors examined the evolution and distribution of macroeconomic indicators using a sample of 201 countries between 1970 and 2022.

The consumer price index, the GDP growth rate, short-term interest rates, fiscal balance and other indicators were examined to identify patterns in the evolution of these indicators before, during and after inflation shocks. Successful and unsuccessful disinflation attempts were distinguished. Successful disinflation processes were characterised by inflation below 10 per cent in the second year following the peak of the inflation shocks, while disinflation processes that were deemed unsuccessful still had inflation above 20 per cent in the second year. The results also demonstrated that, while successfully stabilising countries did not experience a decline in GDP growth, countries that failed to stabilise started to do so even before inflation peaked. Fiscal balance may be an important precondition for disinflation, as countries that successfully implemented intervention started to improve this indicator in the year preceding the peak of inflation, while countries with an unsuccessful attempt began to perceive a sharp deterioration in the indicator in the same period. It can also be observed that in successful cases, interest rate hikes started more than one year before inflation reached its peak during the shock, while in unsuccessful cases the tightening cycle began later and lasted longer.

In conclusion, in successful disinflation cases, a hawkish monetary policy stance was adopted earlier, and therefore interest rate hikes started – and ended – earlier; moreover, the growth rate of GDP was not decelerated by the inflation shock. Successful interventions were also characterised by an earlier stabilisation of the debt-to-GDP ratio. Unsuccessful attempts tended to stabilise inflation above 40 per cent in at least half of the cases; interest rate hikes began later and remained higher for longer relative to successful attempts; GDP growth started to slow even

before inflation peaked; the debt-to-GDP ratio of the government increased and the fiscal balance deteriorated.

The presentations were followed by a discussion amongst the participants. The event can be accessed and viewed in full using this link: [What can we learn from the past - YouTube](#)

Transition Towards Sustainability in Eurasia – Report on the Budapest Eurasia Forum 2023*

Marcell Horváth  – Dávid Szabó  – Györgyi Puhl  – Nóra Anna Sándor 

The Budapest Eurasia Forum, launched by the Magyar Nemzeti Bank (central bank of Hungary, MNB) in 2019, aims to explore the potential for Eurasian cooperation in line with the megatrends shaping our world and provides a platform for European and Asian thinkers to enhance cooperation. The 2023 event addressed sustainable finance, in particular the relationship between digitalisation and green development, which is referred to in the industry as ‘Green FinTech’, the geopolitical dimensions of technological development, technological singularity, the emergence of new economic sectors, the importance of environmental, social and governance (ESG) aspects in the operation of multilateral development banks and financial institutions, and the future of education and work.

In keeping with tradition, the Forum explored the above themes in six thematic panels, with distinguished speakers presenting the latest trends in finance, geopolitics, technology, economics, multilateral cooperation and education. Launched in 2019, the event series has attracted an increasing amount of international attention each year, with 53 speakers from 15 countries attending the 2023 event, and 14 foreign partner institutions and forums supporting the event, including Boao Forum for Asia, Shanghai Forum, Fudan Development Institute, Singapore FinTech Festival, MENA FinTech Association, and the Official Monetary and Financial Institutions Forum (OMFIF). More than 20,000 people followed the presentations and panel discussions on site and online.

On the cusp of a new era

Current geopolitical, economic and financial developments point to a multipolar future, with several countries playing a major role in world politics and the global economy. The Eurasian countries are inevitable players in this process and already play a key role: China, South Korea, Singapore and the United Arab Emirates, among

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others, are leading the way in green transition, technology and innovation. In 2020, the countries of the world faced one of the most significant economic, health and social challenges of the last 50 years, but were able to successfully overcome the pandemic through effective economic and social policies, stronger international relations, innovative thinking and technological advances. One positive outcome of the pandemic was that it accelerated the digital switchover and the transition towards sustainability, and that not only Eurasia but also the world in general has opted for a sustainable economic reboot. As the 500-year Atlantic era draws to a close, it is also worth taking a look at Eurasia's role as a financial centre. Several Asian countries are considered to be among the world's largest financial hubs: the 2023 *Global Financial Centres Index* ranks Singapore, Hong Kong, Shanghai, Shenzhen, Beijing and Tokyo among the top 20 financial centres worldwide. This is a good example of the shift of emphasis towards the East that has taken place in recent years. Hungary is an active participant in the approaching new era: it was the first country in Europe to recognise these trends and to embark on the path of opening up towards the East, which has since proven to be the right move. According to the National Investment Promotion Agency (HIPA), inflows of foreign direct investment to Hungary amounted to an unprecedented EUR 13 billion in 2023, almost double the EUR 6.5 billion registered in 2022. Record-value projects are set to create more than 19,000 jobs. According to *György Matolcsy*, Governor of the MNB, we need to take advantage of the opportunities offered by new technologies, adding that several Asian countries are at the forefront of using sustainable energy sources, which is one of the megatrends of our time. It is crucial not only for Hungary, but also Eurasia and ultimately the whole world to support a dialogue between East and West based on knowledge and knowledge sharing, to ensure a sustainable economic transition. Dialogue accelerates the transfer of knowledge and technology from which all nations can benefit, and for several years now the Budapest Eurasia Forum has provided an excellent platform for this dialogue, strengthening the role of Budapest as an intellectual hub.

The Eurasian road to sustainability

The Forum, which was held for the fourth time in 2023, was entitled '*Transitions for Sustainability*'. This refers to the most important objective of the 21st century, the need for a transition to sustainable economies and to the fact that this process can be achieved through a multidisciplinary approach and dialogue among Eurasian nations. In keeping with tradition, the two-day professional programme started with a high-level opening ceremony.

In his opening address, *György Matolcsy*, Governor of the Magyar Nemzeti Bank, noted that the challenges of the pandemic had been overcome and we were on

the right track to develop a plan that would define the coming decade. Indeed, the concepts of Eurasia and sustainability go hand in hand: they are two sides of the same coin that secure a new *win-win-win-win* world order for all. Referring to the two Hungarian Nobel laureates, *Katalin Karikó* and *Ferenc Krausz*, *Matolcsy* mentioned the increasing importance of knowledge and basic research and, in the context of the Budapest venue, he highlighted Hungary's role as an intellectual hub between East and West.

Finance Minister *Mihály Varga* also addressed the Forum, reiterating Hungary's position that the separation of Europe and Asia is unjustified and impossible. He stressed Hungary's commitment to international cooperation, mentioning its accession to NATO and the European Union, and the Hungarian government's policy of opening up to the East, aiming to develop more active cooperation with Asia.

In the opinion of *Hongbo Wu*, Special Representative of the Chinese Government on European Affairs, peace and development go hand in hand: without peace there can be no development, and without development it may be impossible to maintain peace. He mentioned the UN's 2030 Sustainable Development Goals (SDGs), noting that the implementation of these goals had proven to be more difficult than expected, with several segments earmarked for development tending to regress. *Wu* praised Chinese President *Xi Jinping's* commitment to sustainability as the key to development and his country's openness to sharing knowledge and experience for the common development of the global community. He cited as examples China's domestic and international efforts to eradicate extreme poverty, infrastructure development projects in many developing countries and the sharing of Chinese technologies in various sectors.

Sung-han Kim, Professor at the Graduate School of International Studies at Korea University and former National Security Advisor to the President of the Republic of Korea, spoke at the opening ceremony about the role South Korea could play in global peace and prosperity. Korea has a long history of experience in development policy, having emerged from economic crisis to become one of the world's top 10 economies in recent decades. Given its location on the periphery of the Eurasian supercontinent, Korea maintains good relations and cooperation with Eurasian countries and countries in the Pacific region.

Xuejun Cai, President (CEO) of the Silk Road Fund, highlighted the importance of increasing sustainable financial instruments in the asset allocation of financial institutions, the gradual progress of decarbonisation plans and the role of the market in promoting sustainable development investment.

Following the opening ceremony, European and Asian experts explored the most pressing issues of our time in thematic panels.

Synergies between sustainable finance and digitalisation

The first thematic panel discussion focused on finance and was entitled ‘*Recipe of Sustainable Finance*’. Numerous green and digital initiatives have responded to the challenges of our time. Since the ongoing energy transition, inflation, economic crises, digital and green megatrends all call for changes in the financial system, financial experts around the world are looking for a recipe for a stable, sustainable financial system. The fireside chat and the panel that followed focused on the sustainability efforts of the financial sector and its relationship with the development of digitalisation and technology, with special regard to the role of the FinTech sector in these efforts. Within the framework of the fireside chat, *Anikó Szombati*, Executive Director of the MNB for Digitalisation and FinTech Sector Development, *Nameer Khan*, Chairman of the MENA FinTech Association, and *Shadab Taiyabi*, President of the Singapore FinTech Association, reviewed the role of the financial sector and FinTech in the green transition. *Nameer Khan* stressed that in today’s world, financial service providers are present in all aspects of life and play a key role in the green transition. This was particularly true for FinTech companies, which had now become integrated into all sectors. Their services were used by regulators and were helping to promote sustainability on a number of fronts, such as big data and AI technology to quickly collect and organise data, and blockchain technology to help the financial sector operate more sustainably by eliminating double accounting for carbon credits. The speakers agreed that international dialogue and cooperation between the private and public sectors, in which Singapore was leading the way, were essential in stopping climate change. *Shadab Taiyabi* stressed that the Monetary Authority of Singapore has been working closely with the private sector in every step of the regulatory process, creating a mutually beneficial and supportive environment.

In the panel discussion moderated by *Dániel Palotai*, Executive Director of the International Monetary Fund (IMF), renowned experts such as *Taehyoung Cho*, Director General of the Economic Research Institute of the Bank of Korea, *Kamran Khan*, Head of ESG for Asia Pacific at Deutsche Bank, *Nurkhat Kushimov*, Chief Executive Officer of the Astana Financial Services Authority (AFSA) of the Astana International Financial Centre (AIFC), and *Xin Wang*, Director-General of the Research Bureau of the People’s Bank of China, continued the analysis of the relationship between the financial sector, digitalisation and the green transition. The experts agreed that the green transition would reach all sectors sooner or later, and that in order to remain competitive it would be essential for companies to integrate

ESG guidelines into their operations, as was already the case in many sectors. *Kamran Khan* stressed that in order to implement the green transition effectively, companies needed to be driven by economic interests and that regulators played a key role in this regard. According to *Nurkhat Kushimov*, the role of regulators was particularly important in making inexpensive capital available, as the green transition and the introduction of new technologies often involved high costs. In the past, the two megatrends – digitalisation and sustainability – were separate, but now synergies had evolved in many areas and it was important to continue thinking about how these trends could work together to solve a global problem. Speaking about the tasks of regulators, *Taehyoung Cho* highlighted the importance of information platforms, while *Xin Wang* stressed the role of green finance pilot zones in capacity building, and everyone agreed that the education of and advice to consumers and market players would be essential to achieve the green transition as early as possible.

The relationship between geopolitics and technology

The second panel of the Eurasia Forum was entitled ‘*Geopolitics in technology*’. In recent years, technological advances such as artificial intelligence, smart cities and robotics innovations have had an impact on society, the economy and our governance systems, while geopolitics have also had a significant impact on the technology market. The panel discussion looked at how Eurasian states are positioning themselves in this highly complex technological and geopolitical environment. Another important question of the 2023 geopolitical panel was how technological transformation is affecting the social and economic systems of the Eurasian continent and how it influences geostrategic decision-making. Prior to the panel discussion, *Norbert Csizmadia*, President of the Board of Trustees of the Pallas Athéné Domus Meriti Foundation (PADME), had a thought-provoking conversation with *Huiyao Wang*, Founder and President of the Center for China and Globalization (CCG) think tank, on the role of technology in the changing world order. During the discussion, *Wang* stressed that the new multipolar world order also needed support systems such as China’s Belt and Road Initiative (BRI) and the European Union’s Global Gateway Initiative, both of which effectively supported the connectivity of the continent. *Wang* pointed out that the lack of cooperation between the major powers was exacerbating deglobalisation trends. Although China was one of the best connected countries in the world today, to achieve a breakthrough in the future, it must also become a centre of innovation, and the way to achieve this was through clean energy.

The geopolitical panel was moderated by *Elena Rovenskaya*, Programme Director of the International Institute for Applied Systems Analysis (IIASA). *Ying Rong*, Vice

President of the China Institute of International Studies think tank, *Márton Schőberl*, CEO of the Hungarian Institute of International Affairs, and *Bernard Yeung*, President Emeritus of the Asian Bureau of Finance and Economic Research, participated in the panel discussion, joined online by *Cyn-Young Park*, Director of the Regional Cooperation and Integration Department of the Asian Development Bank (ADB).

In the panel discussion, *Ying Rong* explained that China needed new driving forces for its own development, which it could mainly find in the field of technology and innovation, due to the transformation of its current economic development model. While technological progress could also be frightening, along with its benefits, this fear could be alleviated through dialogue, which was possible in intellectual hubs such as Hungary, he added. According to *Márton Schőberl*, the winners in the current technological race would be those who were willing to change and thus apply the latest technological achievements quickly and accurately. Digitalisation offered an excellent opportunity for the closer integration of Eurasian nations, he pointed out. Professor *Bernard Yeung* warned that the China–US divergence was not only damaging for the Chinese and US economies, but also for the global economy as a whole, stressing that while we frequently heard about cooperation in the field of technology, action was also indispensable, even with the participation of smaller companies. *Cyn-Young Park* pointed out that it was mainly the emerging and developing economies which were affected the most by the growing fragmentation of the global economy amid the geopolitical competition, and in order to continue the interactive and technological revolution, besides cooperation, there was a need for an international science and technology governance system. Members of the panel agreed that in the absence of cooperation, the current technological revolution would stagnate, with a possible negative impact on the achievement of long-term sustainable development goals in Eurasia.

Artificial intelligence and technological singularity

The third panel of the Eurasia Forum was entitled '*Technology: on the way to full digitalisation and technological singularity*'. Digitalisation is at the heart of technological progress and has the potential to bring a new era for humanity. New digital technologies will also undoubtedly play a leading role in accelerating the green transition. The panel examined the impact of digitalisation and technological developments on our social and economic systems, and the potential use of artificial intelligence. The panel discussion featured speakers *Bruno Lanvin*, President of Smart City Observatory, *Ronit Ghose*, Managing Director and Global Head of Citi Research, *Liping Zhang*, Deputy Director-General of Financial Research Institute, Development Research Center of the State Council, and *Yiqiang Zhan*, Vice Dean of the School of Information Science and Technology of Fudan University. The panel

discussion was moderated by *Péter Fáykiss*, Director for Digitalisation at the MNB. The discussion covered generative AI solutions including, specifically, ChatGPT, the role of AI in finance, smart cities and education, and the metaverse. *Ronit Ghose* highlighted the ease of access to new technology and the ability to adapt and use software more quickly than hardware. With regard to the metaverse, he highlighted the convenience features provided by connected technologies, such as the ability to visit places of interest without a guide and to find out about specific places of interest or routes using augmented reality. *Bruno Lanvin* said that by the end of the decade, an additional 3 billion people would need to be housed, with 90 per cent living in cities. As a result, *Lanvin* believed that a significant proportion of the next breakthrough technological innovations would be related to the infrastructure and everyday life of cities. Speaking about his own experience, *Yiqiang Zhan* stressed that he regularly used the technology, for example, for generating personalised testimonials for students, but pointed out that generative AI solutions offered a different vision of education than the current one, and that recognising and adapting to that vision was key to tapping into the potential of the technology. While he had not yet used ChatGPT, *Liping Zhang* believed that the financial sector had no reason to fear new technologies and the rise of digitalisation, as the big data that supported them was now playing an increasing role in the financial sector.

The panel discussion was followed by a discussion between *Sir John O'Reilly*, President of the Khalifa University of Science and Technology, and *Zoltán Cséfalvay*, Head of the Center for Technology Futures at the School of Economics of Mathias Corvinus Collegium. The focus of their discussion was artificial intelligence. *O'Reilly* pointed out an interesting phenomenon, suggesting that ChatGPT was not so much technologically significant as it was socially important. Technological development had accelerated dramatically compared to previous eras, and it was a rather interesting aspect of the question of how much we would be able to keep up with it, he added. One of the biggest challenges was the pace of the change, and therefore it was not the most intelligent or the strongest who would survive, but those who could adapt the fastest, he pointed out.

The first day's programme ended with the ceremonial launch of the latest volume of the Budapest Eurasia Forum. In 2023, the MNB added a new, now third, volume of studies to its unique series of publications launched in 2021 on the occasion of the Budapest Eurasia Forum. The book '*Geo Awakenings – Building a sustainable future in the emerging Eurasian era*' was presented on the first day of the 2023 conference by *Barnabás Virág*, Deputy Governor of the MNB and one of the editors of the book. Eighteen outstanding experts from seven countries – China, Germany, Singapore, the United Kingdom, South Korea, Norway and Hungary – contributed to the volume, which was clear evidence of the growing international network of

contacts that the Magyar Nemzeti Bank has been building year after year. The twelve studies examined and emphasised opportunities for international cooperation from a ‘truly’ Eurasian point of view as a solution to mounting geopolitical tensions, economic and social challenges, and worsening climate change. In order to achieve sustainable development, cooperation must be implemented not only between individual international actors, but also between different disciplines.

The second day of the Budapest Eurasia Forum started with a discussion between *Zsolt Kuti*, Executive Director of the MNB, and *Zoltán Pozsár*, Founder and CEO of Ex Uno Plures Inc., a macroeconomic advisory firm. Regarding the links between geopolitical developments and the evolution of financial markets, *Zoltán Pozsár* said that it was worth paying attention to the financial dimensions of the US–China competition, such as the possible decline in the international use of the US dollar and the changing weight of US financial instruments in global financial systems. Regarding the internationalisation of the Chinese RMB, as a first step, China should be able to pay for its own imports in RMB, and then, by concluding swap agreements under the BRI, the RMB may become an increasingly common international currency, he said. Regarding the geopolitical role of central bank digital currencies, the *m-Bridge* project was mentioned, which would create a digital international payments platform between China, the United Arab Emirates and Thailand, bypassing the Western financial system and the US dollar.

New economic sectors for sustainable development

The second day of the Eurasia Forum continued with the economic panel entitled ‘*Scaling up new economic sectors*’. Digitalisation and technological progress are transforming key economic sectors and creating new ones. In the economic panel, experts looked at how technology-enabled sectors can be put on the path to sustainable growth and become drivers of development.

The panel began with a fireside chat with *Christian H. M. Ketels*, Principal Associate at Harvard Business School, moderated by *Gergely Baksay*, Executive Director of the MNB. *Ketels*, a renowned expert on economic competitiveness, stressed during the discussion that productivity – one of the most important factors in a country’s competitiveness – was not a zero-sum game. In addition to influence in the global market and macroeconomic stability, a network with another, more productive country was one of the most important drivers of prosperity growth. According to the expert, artificial intelligence was creating numerous new investment opportunities that would stimulate economic growth and help overcome the low growth trend at the global level.

Following the opening discussion, a panel discussion commenced, in which participants explored the role that emerging new industries could play in supporting sustainable development. The panel featured experts such as *Chong-En Bai*, Dean of the School of Economics and Management at Tsinghua University, *Mariann Gecse*, Director of Public Affairs and Communications at Huawei Technologies, Hungary – West Balkans, *Chris Leck*, Group Chief Technology Officer, S&TPPO, Prime Minister’s Office, Singapore, and *Lorenzo Tavazzi*, Partner and Responsible for the International Department at The European House Ambrosetti. The discussion was moderated by *Géza Sebestyén*, Head of the Center for Economic Policy, Mathias Corvinus Collegium.

The experts identified numerous growth potentials that sustainable development may bring to the economy. According to *Chong-En Bai*, synergy between policy makers and the private sector was the key to success in creating a new industry. In China, this had been achieved and, working closely with the private sector along pre-defined strategic objectives, the central leadership had fostered the flourishing of sustainable and green transition industries such as electric vehicles, solar energy and batteries. Confirming this, *Mariann Gecse* added that Huawei had developed a charging station to support the electric vehicle industry, which could charge an electric vehicle with enough energy to cover 1 kilometre in 1 second. Huawei’s broader goal to help maximise the number of people benefiting from digitalisation was the *Tech4All* project, where Huawei was using technology to support environmental and climate protection. Europe lacked the production capacity to meet the potentially enormous demand from new industries, said *Lorenzo Tavazzi*. According to the expert, in addition to building integrated value chains, training professionals, cutting red tape and cross-continental cooperation may help meet the challenges of technological development, and cooperation may also help to take advantage of new opportunities. *Chris Leck* pointed out that, in the current global economic situation, food security was an important, almost existential issue for any country. Singapore aimed to triple its agri-food industry by 2030, reducing its dependence on food imports and the impact of any disruptions in supply chains on the island nation. According to the experts, the green transition, artificial intelligence and digitalisation would play a prominent role in the future and may become drivers of sustainable development and productivity.

ESG as a driver for green growth

In the fifth Eurasia Forum panel discussion entitled ‘*The role of ESG principles and guidelines in the operation of multilateral development banks and financial institutions*’, the speakers explored the way in which the ESG framework guided the work of multilateral development banks and financial institutions and vice versa.

The panel discussion focused on the growing demand of market players for sustainable development. Companies, investors, banks and financial institutions were becoming increasingly aware of their social and environmental responsibilities, which generated growing demand for green, sustainable financial instruments. This had implications for financial institutions and multilateral banks, as ESG considerations and ESG standards for their comparability became increasingly prominent.

The panel kicked off with the MNB's International Green Finance Lifetime Achievement Scientific Award Ceremony. The awardee of 2023 was *Jun Ma*, President of the Beijing Institute of Finance and Sustainability (BIFS), whose main achievements include the green finance recommendations of the Chinese government and the development of the country's first taxonomy for green bonds. The award was presented by *Csaba Kandrács*, Deputy Governor of the Magyar Nemzeti Bank in charge of the supervision of financial institutions and consumer protection, who gave a brief speech and held a discussion with the award winner. *Jun Ma* underlined that international cooperation and the free trade of green products and technologies may make a major contribution to achieving global decarbonisation goals, and that the mechanism to stimulate decarbonisation should be a combination of policy instruments that take local conditions into account. In his view, green finance needed to be an ecosystem, but in many cases we were faced with the lack of this ecosystem as well as a shortage of capacity. In response to this challenge, BIFS had recently launched a global initiative to build sustainable finance capacity in emerging markets and developing economies.

The panel was moderated by *Gábor Gyura*, Sustainable Finance Consultant of the United Nations. The moderator welcomed as panellists *Benjamin Cashore*, Director of the Institute of Environment and Sustainability (IES) at the Lee Kuan Yew School of Public Policy, National University of Singapore, *Raekwon Chung*, Nobel Peace Prize Laureate and Board Director of the Ban Ki-moon Foundation for a Better Future, *Andrew Cross*, Chief Financial Officer of the Asian Infrastructure Investment Bank, and *Xufeng Zhu*, Professor and Dean of the School of Public Policy and Management (SPPM), Tsinghua University.

As a starting point of the discussion, the panellists provided insights into market trends in respect of the popularity and implementation of ESG considerations. According to *Raekwon Chung*, one pivotal question was how we could transform the climate challenge into green economic growth, which required shifting competition from a short-term to a long-term approach, and from quantitative to qualitative. For *Chung*, ESG was an attempt to reverse quantitative competition, and a means to that end. In his view, international cooperation and ESG standards had to go hand in hand so that we could move towards long-term sustainability. *Xufeng*

Zhu said that ESG disclosures were a major factor in building and improving the ESG assessment standard system, and stressed that the most efficient factor was to motivate enterprises. *Benjamin Cashore*, as a researcher and practitioner of innovative environmental policy, called attention to the problem that the more stringent the regulations that govern a sector, the lower its initial support and effectiveness. Thus, the real question was how to move on from this low-impact initial phase to a more step-by-step development to achieve high support. He was convinced that the most important aspect of governance was the development of sustainable and effective policies. *Andrew Cross* highlighted the Asian Infrastructure Investment Bank's (AIIB) green priorities, the need to promote regional cooperation and the priorities of infrastructure development for technological innovation and private sector mobilisation. As a multilateral development bank, all of the AIIB's projects must comply with an environmental and social framework, he stressed, and 45 infrastructure projects were implemented in 2023 along these lines. The panellists agreed that the spread of ESG and sustainable finance will only be effective if accompanied by concrete and achievable commitments.

The future of education and work

Entitled '*Transition through education: How to design the future of work and education now?*', the sixth and final panel of the forum explored the future of work and the work of the future from the perspective of the education sector, with a particular focus on education technology (EdTech) innovations and labour market trends. Technological developments have a major impact on the labour market, as well as on education, and new *skills* will also be needed in the labour market of the future. In line with the objective of the 2023 panel discussion, the participants examined the features and good practices of education and training systems that could provide future workers with the skills and knowledge needed to meet new labour market challenges. The panel was inspired by a discussion between *Levente Horváth*, Director of the Eurasia Centre at Neumann János University, and *Renhe Zhang*, Vice President of Fudan University, Shanghai. According to *Renhe Zhang*, one of the reasons behind Fudan University's steady progress in recent years was the continuous integration of the latest cutting-edge technologies into the university's daily life, not only for administrative purposes, but also to maximise the learning experience and to support innovation in teaching methodology.

After a thought-provoking exchange of ideas between *Levente Horváth* and *Renhe Zhang*, the panel discussion featured *Ayham Fayyumi*, Education & Skills Director, PwC Middle East, Education & Skills Practice, *Paul Kim*, Chief Technology Officer and Associate Dean of the world-renowned Graduate School of Education of Stanford University, and *Deepak Ohri*, former founder and CEO of Lebuva Hotels & Resorts

and Chairman of the Board of Florida International University. The panel discussion was moderated by *Attila Kovács*, Dean of the Faculty of Business, Communication and Tourism at Budapest Metropolitan University (METU). In the course of the panel discussion, among other things, the participants discussed the problems of the overall development of the education ecosystem, the prominent role of artificial intelligence, the importance of continuous training, retraining and further education, and the development of entrepreneurial skills. As *Ayham Fayyoumi* pointed out, many of the students starting school today would be working in jobs that did not even exist at present. Education was thus a guiding tool that adapted to the dynamic needs of tomorrow and guided new generations into previously unknown areas of knowledge. According to *Paul Kim*, mastering the 4Cs – creativity, critical thinking, communication and collaboration – would be essential to meet the challenges of the labour market in the coming decades. At the same time, in order to talk about a sustainable future, *Kim* noted we needed two more skills: compassion and commitment. In relation to artificial intelligence, *Deepak Ohri* stressed that – if used appropriately by regulators, policymakers and educators – AI could have a leveraging effect in the education ecosystem. The second day of the Eurasia Forum concluded with a contribution by *Kilhwa Jung*, Chairman of the Korean Foundation for International Cultural Exchange (KOFICE), who presented the expansion and success of the Korean Wave (internationally known as hallyu) abroad and the achievements of Hungarian–Korean relations.

Following the educational panel, *Márton Ugrósdý*, Deputy State Secretary, Head of the Office of the Prime Minister’s Political Director, Cabinet Office of the Prime Minister of Hungary, and *Jeffrey Sachs*, Director of the Center for Sustainable Development, Columbia University, discussed online the main lessons of today’s wars and rivalries between the major powers. According to *Sachs*, it was particularly important to listen to others, to communicate openly and with mutual respect, and to monitor dangerous phenomena such as climate change or the incredibly large income gap between different social groups. Regarding the Eurasian relationship, *Sachs* pointed to thousands of years of history and the importance of trade relations between the West and the East. In his opinion, a change in the European way of thinking was necessary, as it was clear that the development of European countries was not possible without good relations with China.

Finding the right answers is key

The Eurasia Forum 2023 ended with the closing remarks of *Barnabás Virág*, Deputy Governor of the Magyar Nemzeti Bank, who emphasised that the Eurasia Forum aimed to provide a platform for those interested in the future of Eurasia. He underlined the message of *Hongbo Wu*, Special Representative of the Chinese

Government on European Affairs, who said that ‘without peace there is no economic development, but without economic development there will be no long-term peace’. He also referred to the words of *György Matolcsy*, Governor of the MNB: Eurasia and sustainability are two sides of the same coin. We lived in a very complex world, which was facing unforeseen shocks, added the Deputy Governor. According to *Barnabás Virág*, the world was currently facing three challenges: technological, geopolitical (including climate change) and financial.

The MNB will celebrate the 100th anniversary of its establishment in 2024. We hope to see the Budapest Eurasia Forum return for the fifth time this year as a flagship event of the centenary celebrations.

Report on the 14th Annual Financial Market Liquidity Conference*

Zsuzsa R. Huszar^{1b} – Jinlong Li^{1b} – Xinglin Li^{1b} – Dehua Xia^{1b}

1. Opening of the AFML conference and the first keynote speech

On the 9th and 10th of November 2023, the Corvinus University of Budapest (CUB) hosted the 14th Annual Financial Market Liquidity Conference (AFML), one of Hungary's most important international financial conferences. The conference's main organiser — the Institute of Finance at CUB — continued its long-term collaboration with the Game Theory Research Group of the Centre for Economic and Regional Studies. This year, the organising team included a new academic member organiser, the Faculty of Economics at Eötvös Loránd University. Continuing with the tradition, *Professor Péter Csóka* chaired the scientific committee, while this year's chair of the local organising committee was *Assistant Professor Attila Víg*.

The conference was also supported by prestigious local finance industry partners, KELER CCP, Morgan Stanley and OTP Bank. In addition, for the first time, the conference organisers included a “Women in finance” special session with mentoring, supported by a grant from the Academic Female Finance Committee (AFFECT) of the American Finance Association (AFA). The 14th edition of the AFML was also unique in terms of the number of keynote speakers, hosting five keynote speakers, four in person and one online.

The conference was opened by *Acting Rector Professor Lajos Szabó*, who acknowledged the long-term success of the conference and welcomed the local and international academics and industry professionals for two days of intensive research collaboration. After the official welcome message by the university leadership, the head of the Finance Institute, *Associate Professor Kata Várdi*, also briefly welcomed the academic and industry attendees and thanked the sponsors. She formally kicked off the conference and introduced the first keynote speaker, *Professor Thierry Foucault* from HEC Paris, who presented an insightful quantitative

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

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finance research paper on a special group of high frequency traders (HFTs) engaged in market making.

Professor Foucault's research, a collaborative effort with two colleagues, focused on algorithmic pricing and liquidity in securities markets. The authors explored the interaction of "Algorithmic Market-Makers" (AMMs) using Q-learning algorithms in a standard microstructure environment and compared AMMs' behaviours to the expected outcomes based on the existing theories. Their comparison was conducted under two scenarios: First, in a static environment with one trading round per period and second, in a dynamic environment with two trading rounds per period.

In the static environment, the analysis consisted of three steps: (1) deriving equilibrium prices using two benchmark cases (i.e. prices from a multiple dealer competitive Nash-Bertrand equilibrium and from a monopoly case); (2) describing the pricing policy from Q-learning algorithm used by AMMs; and (3) comparing the pricing policy offered by AMMs to the two theoretical benchmarks. The analysis provided several key insights conditionally on the market settings. In the single dealer case, AMMs using the Q-learning algorithm behaved more competitively than benchmarks, while in the duopoly case, the price posted by two competing AMMs were far above the Nash-Bertrand equilibrium price. In the presence of two AMMs and changing adverse selection, the quotes posted by AMMs were less competitive with more adverse selection, implying monopolist behaviour by the AMMs.

Subsequently, the welfare implications of AMMs were discussed where the total welfare effect is decomposed into consumer surplus and producer surplus effect. The consumer surplus and total welfare increase with the variance of clients' private valuation as demand elastically is lower, making the possibility of trade execution at a higher price. However, the increase in the volatility of asset payoffs is associated with lower profits, consumer surplus and hence total welfare. In addition, the study also documented that on average algorithms use a higher price in the second trading round than in the first with reduced adverse selection, resulting in AMMs using less competitive prices. As a result, the spreads tend to widen with adverse selection being reduced over time, a result which was contrary to the expectation from a competitive environment.

The main conclusions from this research were the following: Adverse selection cost is to be reflected in the quotes, while the quotes are updated in response to the observed order flow. AMMs' behaviours are quite different from what standard theories predict, with quotes generally above the competitive level and becoming less competitive with adverse selection being reduced over time.

2. AFML conference first day parallel sessions and the second keynote speech

Day one of the conference was heavily packed with twelve 30-minute presentations in three parallel sessions in the morning section. The session topics were titled “Interconnectedness”, “Market liquidity and investments”, and “Corporate governance and corporations” chaired by *Professor Barbara Będowska-Sójka* from Poznań University of Economics and Business, *Professor Niklas Wagner* from University of Passau, and *Professor Álmos Telegdy* from CUB, respectively. The conference organisers assigned expert reviewers as discussants to papers for which the presenters requested formal feedback with the objective of helping with future publications.

After a brief lunch break in the main aula of the university, there was time for networking and an opportunity to review research posters. The afternoon continued with another twelve 30-minute paper presentations, in three parallel sessions. The “Machine learning” session was chaired by *Professor Andras Fulop* from ESSEC, the “Stock markets, households” session was chaired by *Associate Professor Zsuzsa R. Huszar* from CUB, and the “Sustainable finance” session was chaired by *Professor Thomas Walker* from Concordia University.

After the parallel session and a quick coffee break, the first day of academic talks was concluded with the first keynote presentation by *Professor Jonathan A. Batten* from RMIT University, Australia. Professor Batten presented his research with two colleagues on insider trading and market manipulation. They revealed that market manipulation (MM) and insider trading (IT) may be opportunistic, but usually is strategic. By strategic, the authors mean that the potential offenders strategically weigh the potential profits against the probability of detection and potential penalties.

Detection of IT trades on over-the-counter (OTC) markets were generally more difficult than on organised exchanges, because market detection using market surveillance techniques for MM and IT tend to be limited. While Professor Batten advocated that strong regulatory oversight and market transparency are essential to prevent misuse and promote fair trading practices, he also stressed the importance of promoting sound ethical principles and individual responsibility for market participants.

The presentation aimed to highlight the issues and implications of MMs and ITs on financial markets related to liquidity, market timing and market concentration, among other things. The authors included a regulatory review and found that while

the surveillance focus has been on concealment tactics, prosecution usually relied on whistleblowers. Professor Batton also highlighted that while ITs are often illegal when executed based on private information, these trades can be also opportunistic and liquidity driven. Differentiating between the two forms of IT is often overlooked.

While the academic consensus tends to label informational IT as bad, there is an ongoing debate. Some economists and legal scholars suggest that laws against insider trading should be repealed. Opponents of regulations argue that insider trading could benefit investors in the market, by speeding up the information dissemination process. In the presentation, two examples of insider trading related to Raj Rajaratnam and Galleon Group were also mentioned.

In the market manipulation overview, Professor Batton introduced several types of market manipulation, including liquidity pools, painting the tape, pump and dump, spoofing, front running and others. As an example, he mentioned the silver crisis, which resulted in a USD 150 million lawsuit against the Hunt Brothers. The silver fix was a daily benchmark process in the silver market, where a panel of banks determined the daily silver reference price. Similarly, to the famous LIBOR scandal, in the silver scandal key banks faced allegations of manipulation and collusion to influence the benchmark silver price for their own benefit.

Professor Batton concluded his keynote speech with some key lessons for markets: (a) limited industry-based market surveillance; (b) individual incentives driving unethical behaviour; (c) organisational culture may be responsible for facilitating or encouraging unethical behaviour; and (d) the frequent failure of top-down regulatory apparatus, and overreliance on whistleblowers. As final observations, he stressed the importance of ethical corporate strategies and especially the need for companies to evolve ethical considerations from the top down and holding individuals responsible for their own actions.

3. AFML conference second day morning parallel sessions and the third keynote speech

The second day started with three parallel sessions in the morning, the “Loans and lending” session, chaired by *Associate Professor Dániel Havran* from CUB, the “Theory and investments” session, chaired by *Assistant Professor Tomy Lee* from the Central European University (CEU), and the “Banking” session, chaired by *Associate Professor Barbara Dömötör* from CUB.

After the parallel sessions, *Associate Professor Zsuzsa R. Huszar* chaired the “Women in finance” session supported by AFPECT, where she highlighted some key statistics on the underrepresentation of women in the finance industry and in

finance academia. She pointed out that in financial institutions globally, less than 20 per cent of board members and less than 2 per cent of the CEOs are female. The session sponsor AFFECT aims to address the gender inequality issue by promoting the advancement of women academics in the field of finance through research, networking and mentoring, among others. In the spirit of AFFECT's mission, Associate Professor Huszar proposed the establishment of a EuroAsian Female Finance Academics Association (EFFAA) to provide similar mentoring, networking and collaboration opportunities for female academics in Central and Eastern Europe (CEE) and in Asia and encouraged conference participants to sign up.

The distinguished first female keynote speaker in person of the AFML, *Professor Rose Neng Lai*, from the University of Macau, provided further statistics on female underrepresentation in decision-making positions, especially in the technology sector.¹ She cited common social media headline posts, such as “Women are less ambitious than men. Female leaders tend to take less risks with their business decisions”. She explained that the motivation for the study was the “common wisdom” that women are more risk-averse and ethical, and decided with two of her colleagues, Shaohua Tian and Yang Zhang, to examine this issue empirically in the context of US tech firms. In their working paper entitled “The Myth of Risk Aversion from Female Leadership – the Case of US High-Tech Sector”, their research aimed to explore whether gender plays a role in risk taking and what kind of risks female leaders tend to take.

Professor Lai described her dataset of over one thousand US high-tech firms from 1996 to 2021 in great detail before introducing the key results. While on average no significant effect on risk taking is associated with gender in US firms, the study shows that female CEOs in US high-tech firms tend to take more risk. More importantly, the higher risk taking tends to pay off, as these firms, firms with female CEOs are also associated with higher returns. The authors differentiated between total and idiosyncratic risk, but the results were similar. Interestingly, consistent with social media posts, female board members at US high-tech firms tend to take less risks. While macro conditions and economic uncertainty also play role, the results tend to be robust, and the findings are clearly inconsistent with the usual preconception that women tend to be more risk averse, noted Professor Lai.

In the sample, the female CEOs likely self-selected their jobs; thus, the empirical concern arises whether technical background may contribute to their “unexpected” risk-taking behaviour. Interestingly, the study found that not the tech background, but rather the financial background supports the risk taking as female CEOs with finance degrees “seem to know what they are doing and seem to take higher risk,

¹ During the two prior AFML conferences, effected by the Covid-19 pandemic, Professor Mariassunta Giannetti, from the Stockholm School of Economics, participated already as the first female keynote speaker, but only in online format via MS Teams.

according to our data”, according to Professor Lai. Finally, the authors also examined the attitude of female CEOs and female board members towards innovation and found that while female CEOs were not significantly associated with higher level of innovations, female board members were. Touching on the hot topic of Environmental, Social and Governance (ESG) issues, the authors documented that female CEOs and female directors tend to be more concerned about sustainability and compliant with environmental regulations than their male counterparts. These results are important in supporting gender equality and diversity at boards, to support the move towards a sustainable future, from the top down.

After the inspiring presentation by Professor Lai, the first CEE academic mentoring event took place in the Faculty Club. The mentoring session was organised by Associate Professor Huszar with support from AFFECT and aimed to provide a platform for female academics for gain access to senior industry and academic mentors in a comfortable setting and learn from each other’s experience. In the spirit of equal opportunity, the mentoring session welcomed all interested participants irrespective of gender, race or age. The mentoring session was organised around six tables with designated topics, such as academic career, green finance, quantitative finance, and central clearings and settlements. At each table there were 2 mentors, one industry and one academic mentor, and a couple of mentees, previously matched based on their research interest. From the university leadership, which has been actively supporting the initiative, *Associate Professor Réka Vas*, Vice Rector of Teaching, participated as a mentor. Industry mentors such as representatives of Hungary’s central clearing facility, KELER CCP (Csilla Szanyi, CRO KELER CCP and Babett Pavlics, CEO KELER CCP), the Magyar Nemzeti Bank (MNB), the central bank of Hungary (Eszter Baranyai, Senior Expert at the MNB and Eszter Boros, International Expert at the MNB) and the Bank of China were also invited to stimulate discussion on real world issues where academic research can be particularly valuable. Overall, the event, which was open to all conference participants, drew 30+ participants, the majority of them women.

4. AFML conference second day afternoon session with the fourth and fifth keynote speech

The last part of the conference concluded with two distinguished invited speakers, *Professor Michael Halling* from the University of Luxembourg and *Professor Thomas Walker* from Concordia University, Canada.

The first keynote speech in the afternoon session by Professor Michael Halling presented a paper entitled “Firm-specific Climate Risk Estimated from Public News”, co-authored with Thomas Dangl and Stefan Salbrechter. He highlighted

the opportunities that news data offers for academic research. For example, with news, we can have long time-series historical data, while also have forward-looking information, with high-frequency. However, the benefit of the “large news data” also poses some challenges in terms of processing and data management, requiring the use of Natural Language Processing (NLP) tools. Additionally, news is inherently noisy, and the prevalence of fake news is a possible existing issue, making it difficult to address and potentially working against our efforts to find any effects. Thus, what do they do to solve these issues in firm-specific climate risk?

They employed a “white box” machine learning approach to generate climate-related topics focusing on both risks and opportunities. After that, they calculated firm-specific exposures to climate risks by analysing news data, and labelled firms as green or brown based on the firm’s regulatory climate risk and physical climate risk portfolio. In the end, they computed regulatory and physical climate risk betas for a total of 9,000 companies to facilitate the generalisability of their approach.

Professor Halling and his coauthors were the first to document a statistically significant positive climate risk premium. They also documented a regime shift around 2012 and have shown that while the climate risk premium was positive at about 1.54 per cent from 2002 to 2012, it turned negative to about –2.56 per cent from 2012 to 2020. These findings, and the evidence of positive and negative risk premiums during different time periods, reconcile the conflicting climate risk premiums in the existing literature. Lastly, the high correlation of 0.64 between the news-based green-minus-brown (GMB) portfolio and E(SG)-sorted GMB portfolio indicates a significant relationship, suggesting that the information extracted from news sources closely aligns with E(SG) scores.

The last keynote speech was delivered by Professor Thomas Walker, who presented a paper entitled “Analysts and Affiliated Money Managers: Do They Talk More Than They Should?”, co-authored with Sergey Barabanov. The authors aimed to solve two main research questions: first, which types of institutions or analysts are the most informed or better informed or least informed? Second, is there consistency between analyst actions and trading by affiliated money managers? Based on previous research, it was found that institutional trading is mostly based on information and can also increase the speed of adjustment to new information, as institutions react to public information and events, such as post-announcement drift.

Moreover, informed investors have several advantages, and they can benefit twice through trading aggressively prior to the public announcement and by unwinding part of the prior trade once the information becomes public and is partially or fully reflected in the stock price. While for individual investors, they may bear most of

the losses in sued companies, and lack institutional skills, resources and analytical capabilities, they may revert to litigation as a substitute for corporate governance and monitoring. This research helps provide insights on information dynamics within financial institutions, the advantages of informed investors and the challenges faced by individual investors.

5. Summary

The 14th AFML conference attracted more than 130 participants during the two-day event. The Institute of Finance faculty was well represented with a wide range of topics from Emerging Market diversification, through sustainability and household finance to crypto assets. The conference also showcased effective mentoring by CUB senior faculty as several CUB students also presented research papers. PhD students Markus Martin and Fanni Dudás presented on the hot topic of sustainability, mentored by Professor Edina Berlinger, Associate Professor Barbara Dömötör and Associate Professor Helena Naffa. It is noteworthy to mention the research inspired CUB undergraduate student Boglárka Sass and master student Pálma Bernadett Szilárd, who also took part by presenting their research work under the supervision of Milán Csaba Badics, their thesis advisor. Sass presented her work on crypto market liquidity commonality in the poster session, while Szilárd presented her paper on geopolitical risks arising from OPEC decisions on the first day of the conference.

The conference featured five keynote speakers with renowned names such as Professor Jonathan A. Batten, Professor Thierry Foucault, Professor Michael Halling, Professor Rose Neng Lai, and Professor Thomas Walker. The keynote speakers represented finance academic experts from four continents, from the Americas, Europe, Asia and Australia Pacific. Additionally, four invited speakers also presented at the AFML conference: Professor Barbara Będowska-Sójka, Professor Igor Lončarski, Associate Professor Gábor Neszveda and Professor James Steeley.

Overall, the two-day, 14th edition of the AFML conference saw a total of 38 paper presentations and 6 posters. These presentations covered a wide range of theoretical and empirical topics, providing a unique opportunity to learn about current research techniques, interests and networking. For the first time, there was also an organised networking session where junior and senior researchers were matched based on research interests. The conference also actively promoted collaboration and connection with the industry during the mentoring session and throughout the conference, with a large number of industry representatives from Morgan Stanley and the management of KELER CCP.

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Manuscripts should be submitted in accordance with the following rules:

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- The unnumbered footnote of the author's name contains his/her position, the institution the author works at, his/her email address and any other relevant information and acknowledgment regarding the article.
- Papers always begin with an abstract which should not exceed 800–1,000 characters. In the abstract a brief summary is to be given in which the main hypotheses and points are highlighted.
- Journal of Economic Literature (JEL) classification numbers and keywords should be given (three at least).
- Manuscripts should be written in clear, concise and grammatically correct Hungarian and/or English. Chapters and subchapters should be bold.
- Manuscripts should contain the list of references with the first and surname of the authors (in case of non-Hungarians the initials of the first name is required), the year of publication, the exact title of the book, the publisher, the place of publication. In case of papers, the exact title of the journal, the year, the volume, and the pages should be indicated. References in the text should contain the surname and the year. When citing the exact page should be indicated.
- Tables and figures are to be numbered continuously (chapters and subchapters should not contain restarted the numbering). Every table and figure should have a title and the units of quantitative values are to be indicated. Tables are to be made in Word, while figures must be edited in Excel. Notes and sources are to be put directly at the bottom of the tables, figures.
- Equations should be aligned to the right and should be numbered continuously in parenthesis. (Chapters and subchapters should not contain restarted the numbering.)
- Manuscripts are to be sent to the Editorial Office only. Papers are peer-reviewed by two independent and anonymous reviewers.
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Thank you!

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