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Experiences with the Introduction of a Payment Moratorium in Hungary*

Áron Drabancz – Gabriella Grosz – Alexandr Palicz – Balázs Varga

The payment moratorium, which was introduced in the wake of the coronavirus pandemic in Hungary as well, has become an internationally widespread crisis management tool. In our study, we analyse the demographic and income characteristics of bank clients who have participated in the payment moratorium and the direct impact of the payment moratorium on the liquidity of debtors and on bank profitability. The analysis is based on transaction-level data available to the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB) that is detailed in international comparison as well. Based on our examination, the payment moratorium has proven to be an effective tool for mitigating the short-term default risk of potentially vulnerable debtors. It has also provided significant additional liquidity at the level of the national economy to offset the negative impacts of the pandemic, while causing only moderate direct costs at the level of the banking system. On the whole, the payment moratorium can be considered an effective and efficient crisis management tool for exogenous economic shocks similar to the coronavirus pandemic, which is also confirmed by its international prevalence.

Journal of Economic Literature (JEL) codes: E32, E58, G21, G28, G32, G33, G38, M48

Keywords: coronavirus pandemic, financial stability, payment moratorium, credit risk, financial regulation

1. Introduction

The coronavirus pandemic has caused a serious, protracted financial and economic crisis around the world. During the first wave, closures broke the continuity of supply chains (*Figure 1*), causing significant disruptions in the real economy. The deteriorating macroeconomic environment affects the financial sector primarily through mounting credit losses and the rise in liquidity and funding risks (*EBA 2020a*; *FSB 2020*). At the same time though, with health hazards and digitalisation

* 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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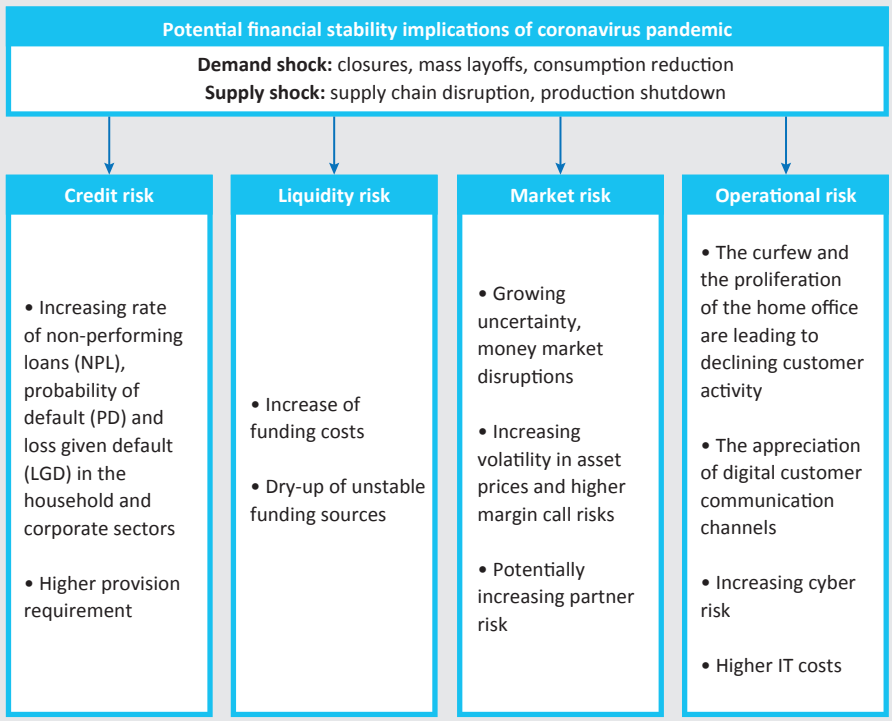
coming to the fore, operational risks and cyber defence (*BIS 2021*) are becoming more relevant.

Figure 1
Potential transmission mechanism of the coronavirus pandemic



Source: Based on the MNB data (2020a)

The short-term global financial stability risks posed by the coronavirus pandemic may be mitigated by crisis management interventions of unprecedented size. Until the launch of coronavirus vaccinations, economic recovery depends on prolonging the supportive measures of the governments and the central banks (*BIS 2020a*; *IMF 2021*). Within the framework of these measures, decision-makers tried to mitigate negative impacts with the help of fiscal, monetary, micro- and macro-prudential tools as well. Governments worldwide provided support worth around USD 12 trillion to households and businesses (*IMF 2020*) via fiscal policy measures. In terms of monetary policy, as a result of the pandemic, the central banks of the G10 countries increased their balance sheets by around USD 7.5 trillion, and about 20 developing economies have introduced an asset purchase programme for the first time ever. Microprudential supervisory interventions include the temporary

suspension of capital and liquidity regulations and the temporary authorisation of limit violations, which played a role in the increase of financial institutions' lending capacity. The macroprudential framework which has been created in the recent years has successfully stood its first crisis test since the global banking system faced the economic shock of the coronavirus pandemic with high capital and liquidity reserves and adequate resilience (*Terták – Kovács 2020*).

The economic policy responses to the economic challenges posed by the pandemic primarily support the financial system in two ways. First of all, they strengthen the lending capacity of the financial institutions since this is the best way that they can mitigate real economic recession. Second, they enhance the stability of the financial system which may be endangered primarily by the rising credit loss. Decision-makers basically maintained banks' lending capacity by easing capital requirements and increasing liquidity. In addition, fiscal policy measures, state and central bank credit and guarantee schemes and payment moratoria provide significant help in bridging temporary liquidity shortages, thus protecting supply chains and maintaining the functioning of the economy. Furthermore, payment moratoria counterbalance potential short-term credit losses stemming from the deteriorating payment ability of distressed debtors. However, proactive bank restructurings and the regulatory incentive for bank balance sheet clean-up can help the most in maintaining portfolio quality in the long term (*BIS 2020b*).

In our study, in relation to the coronavirus pandemic, payment moratoria are discussed, as the most widespread instrument applied for the mitigation of short-term credit losses, with a focus on Hungary's approach. We discuss the transmission mechanism of the payment moratorium in the second section, while in the third section, we also analyse the international experiences with the use of this measure. In part four we examine the impacts of the domestic payment moratorium on the households and businesses participating in the programme, based on internationally outstanding, uniquely detailed data available to the MNB. In doing so, we also address the impact of the payment moratorium on liquidity and on banking profitability, and we argue that this measure has effectively mitigated households' liquidity shortage, while it has caused only limited and manageable losses for the banks. In section five, the expected impacts of the extension of the payment moratorium until June 2021 are presented. Finally, in light of the favourable impacts and potential costs of the moratorium, the study concludes that the measure has proved to be an effective crisis management tool in total.

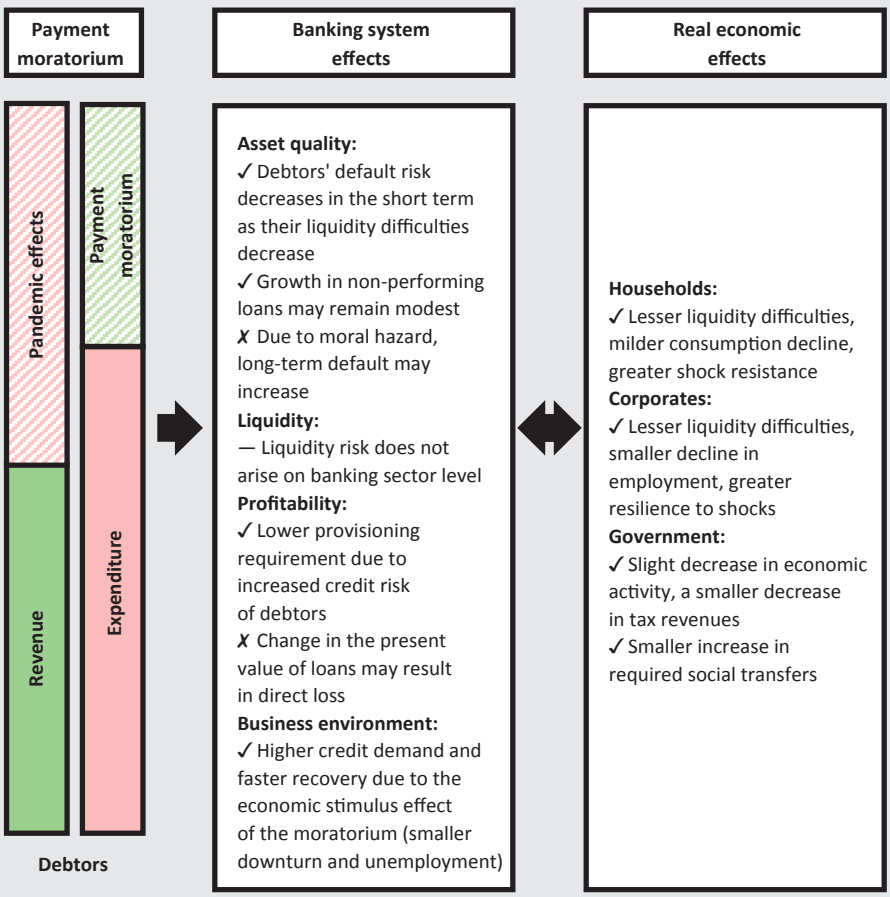
2. The transmission mechanism of the payment moratorium

The basic purpose of the payment moratorium is to aid debtors who are struggling with temporary liquidity shortages, but who are solvent over the longer term, thus avoiding a drastic increase in the non-performing loan portfolio and maintaining economic activity (*Figure 2*). A payment moratorium counterbalances the income loss of households and companies resulting from the coronavirus pandemic via the temporary suspension of payment obligations. The moratorium prevents or delays potential non-performance, thus mitigating the immediate impact of the pandemic and providing time for the necessary adaptation by market actors. By maintaining banks' portfolio quality, the moratorium reduces the extent of and provides more time for the potentially necessary loan loss provisioning. By mitigating and prolonging the risks posed by the pandemic, the moratorium also reduces banks' potential capital losses.

The payment moratorium decreases the liquidity inflow of the banks from loan repayment, but liquidity risks do not emerge at the banking system level. This is because delayed instalments ultimately appear on the liability side of the banks at the systemic level, via the increased savings or consumption of the debtors, as if debtors had completed their repayment obligation. However, the liquidity effect among banks may be uneven, which may require additional liquidity for institutions possibly encountering a more difficult situation, which is supported by the MNB with monetary policy instruments (*MNB 2020b*).

In the international literature and professional community, the assessment of the impact of the payment moratorium is not clear: in earlier cases, banks drew attention to the default risk stemming from increasing moral hazard, while supporters pointed out the increased amount of time that borrowers could spend on gathering information and accumulating liquidity because of the moratorium. Furthermore, supporters also highlight that a properly introduced moratorium may even improve non-performing debtors' willingness to pay in the long run, due to increased trust in the system (*Collins – Urban 2018*).

Figure 2
Transmission mechanism of the payment moratorium



Source: MNB

The impact of granting a deferral on bank impairment and profit is regulated by international accounting standard IFRS 9. According to IFRS 9, lenders must recognise an impairment corresponding to the expected annual loss on transactions related to lenders' performing exposures. If the transactional credit risk increases significantly, exposures must be classified into the so-called Stage 2 (financial instruments with significantly increased credit risk) or Stage 3 (non-performing financial instruments) categories. In Stage 2 or in Stage 3, however, the amount of the impairment should be determined on the basis of the expected loss over the total lifespan. In Stage 3, the interest income of the transactions should be calculated on the basis of the net book value (*BIS 2020c*), resulting in a significant negative income impact. If the general regulations on deferral were applied to payment moratorium, it would result in the wholesale classification of the transactions into Stage 2 or Stage 3 and would seriously decrease the result and deteriorate lenders' capital position.

In order to avoid the broad impairment of credit transactions under a moratorium, the international regulatory authorities issued resolutions on the exceptional accounting treatment of payment moratoria introduced in the wake of the COVID-19 pandemic. The International Accounting Standards Board (IASB), the Basel Committee on Banking Supervision (BCBS), the European Banking Authority (EBA)[1] and the MNB issued guidelines[2] and an executive circular[3] that participation in a payment moratorium introduced in the wake of the coronavirus pandemic does not on its own indicate a significant rise in credit risk, and thus does not result in the necessity to reclassify the exposures as financial exposures with increased risk (Stage 2) according to IFRS 9, nor to classify the exposures as restructured or non-performing claims. The regulatory authorities argue that entering the moratorium itself is not an event referring to the increased credit risk of clients, but represents participation in a broad governmental programme that mitigates debtors' temporary liquidity shortages. Therefore, according to the authorities, the accounting treatment of the payment moratorium differs from forbearance measures initiated by debtors due to a deterioration in their solvency, and participation in the moratorium on its own does not necessitate loan loss provisioning. Nonetheless, banks already started preparing for the management of potential future losses in 2020 by generating a larger amount of portfolio-level impairment. In Hungary, during the first nine months of 2020 HUF 294 billion of impairment and provision was formed, while in same period of 2019 it was only HUF 30 billion.

The potential profitability impact of the payment moratorium depends on its implementation details and on the change in the present value of loans subject to the moratorium. Although the payment obligation is suspended for debtors participating in the moratorium, payments become due regardless of the moratorium and shall be paid after its expiration according to the implementational details. Since the moratorium does not affect the legal basis of the lenders' claims, lenders do not suffer direct interest loss according to the practices of most countries. Lenders' potential loss stemming from the payment moratorium is the result of the impact of the moratorium on the present value of the loans and therefore it is highly dependent on the specific form of the moratorium. Present value change or direct bank losses do not arise if the interest of unpaid capital is capitalised and compound interest is applied. If the capitalisation of interest is omitted, however, lenders suffer the loss of the present value, which stems from the loss of the potentially recoverable additional interest. The accounting of the decrease in the loans' present value differs from one lender to another. It may appear as provisioning

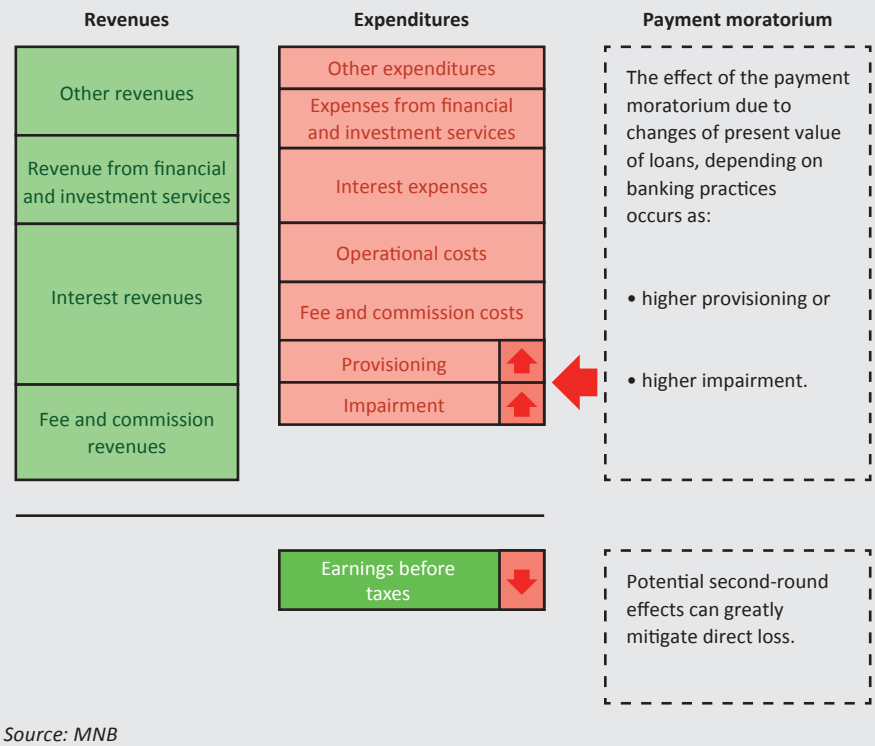
[1] https://eba.europa.eu/eba-provides-clarity-banks-consumers-application-prudential-framework-light-covid-19-measures, and https://eba.europa.eu/regulation-and-policy/credit-risk/guidelines-legislative-and-non-legislative-moratoria-loan-repayments-applied-light-covid-19-crisis

[2] MNB Press release: https://www.mnb.hu/sajtoszoba/sajtokozlemenyek/2020-evi-sajtokozlemenyek/magyarorszagot-kovette-az-eu-a-fizetesi-moratorium-banki-hatasainak-megiteleseben

[3] MNB Executive Circular: https://www.mnb.hu/letoltes/tmp3dd8-tmp-23297446.pdf

or as impairment as well. The resulting potential loss of the lenders therefore immediately decreases the result when debtors enter the moratorium (*Figure 3*).

Figure 3
Schematic profit and loss statement of the banking system and the direct detrimental impact of the payment moratorium



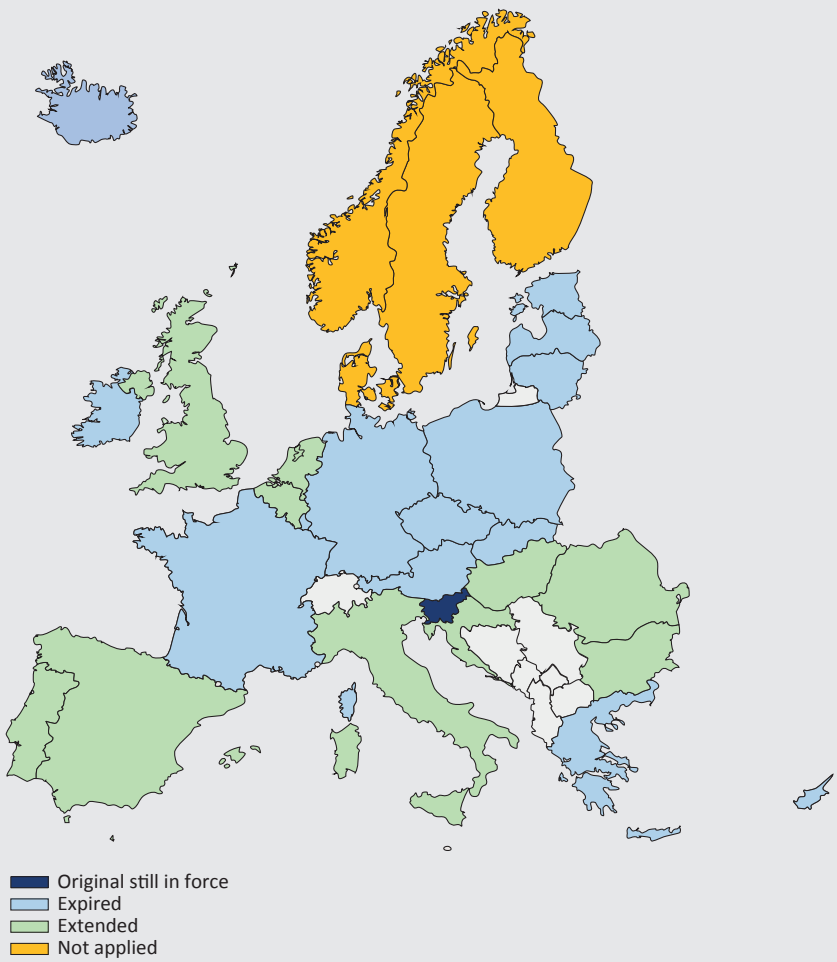
Source: MNB

Lenders' potential losses may be largely counterbalanced by the smaller capital loss stemming from the maintenance of portfolio quality and by the smaller decline in demand stemming from the support for the general business environment. By mitigating the liquidity shortfall, payment moratorium may contribute significantly to maintaining the supply chains and economic capacities impacted by the pandemic. The liquidity impact, which is significant even at the macroeconomic level, may substantially improve the factors that determine portfolio quality the most, such as economic growth and employment.

3. International practice of payment moratoria

Payment moratoria of some kind have been introduced almost everywhere, in a total of 23 countries, except for the northern European ones, in the European Union (*Figure 4*); however, the measures introduced differ in many of their characteristics. A high degree of heterogeneity can be observed in terms of the legal form of introduction, the conditions of eligibility, its subject, the means and timespan of application and the potential prolongation of the measures in light of the pandemic situation.

Figure 4
International practice of payment moratoria in the EEA countries and the United Kingdom (as of 2 February 2021)



Source: Data retrieved from European Systemic Risk Board (ESRB), MNB

– *Legal form:* In the EU, in addition to Hungary, fourteen countries acted within the legal framework, while nine countries developed common practices for a payment moratorium by adopting a banking association recommendation.

– *Eligibility:* A broad-based, unconditional payment moratorium on corporate and household loan instalments, as in Hungarian practice, was not common in other EU Member States. In the international context, a typical feature of the measures is that moratorium can only be granted if certain conditions are met. Such conditions include, for example, being unemployed, operating or being employed in an industry affected by the pandemic, a drop in income or revenue proven to be the result of the situation, or residing or operating in the economic and geographical areas particularly affected by the pandemic.

– *Application:* In terms of the entry into the moratorium, Hungary uniquely implemented the opt-out type of mechanism, i.e., the measure was automatically applied for the debtor, and no separate request was needed to be submitted. In the other EU Member States, an opt-in type of measure was implemented, i.e. the debtor could submit a request for the moratorium.

– *Subject of the payment moratorium:* Similarly to Hungary, in most EU countries, the measure applies to both interest and principal, with the exception of Germany and Spain, where the moratorium only applies to principal.

– *Period of the payment moratorium:* No payment moratorium was imposed in the Nordic countries at all, while in the case of the other northern countries (United Kingdom, Ireland and Iceland), measures were only introduced for a short period of 3–6 months. Of these, Ireland extended the payment moratorium by 3 months, while in the UK a limited moratorium can be exercised for another 3 months, for a total of 6 months. Apart from these, no payment moratoria are currently in effect in the northern countries. EU countries typically declared a payment moratorium for a period of 3 to 6 months, while Central and Eastern European countries defined a longer, 6- to 9-month period for the payment moratorium. Among the indicators measuring the competitiveness of pandemic control, the period of the payment moratorium announced in Hungary is outstanding in an international context, as *Báger – Parragh* (*2020*) also points out.

– *Extension:* Due to the protracted pandemic, the measures originally introduced have been extended in several countries, such as Austria and Portugal. The extension was granted in countries approaching the original expiry of the payment moratorium or implementing a payment moratorium that had already expired in the meantime. In general, according to international practices to date, the extensions were applied to a more limited range of eligible debtors, such as unemployed debtors with confirmed loss of income or those working in tourism, and they were effective typically until the end of the year or by June 2021. After

the expiry of the payment moratoria announced at the time of the pandemic outbreak, the payment moratoria of only 11 countries (UK, BG, HR, RO, SI, BE, NL, IT, MT, PT and ES) are still in effect, in addition to Hungary (*Table 1*).

Table 1
International comparison of payment moratoria in the EEA countries and in the United Kingdom (as of 2 February 2021)

Region	Country code	Payment moratorium in effect	Opt-in/ Opt-out	Mandatory for banks	Scope of eligibility	Period of the moratorium (month)	Period of extension included (month)
Northern countries	DK	No	No	No	None	0	0
	FI	No	No	No	None	0	0
	IE	Expired	Opt-out	No	General	6	3
	SE	No	No	No	None	0	0
	UK	Extended	Opt-in	No	Limited	6	3
	IS	Expired	Opt-in	Yes	Limited	6	0
CEE and Baltics	SK	Expired	Opt-in	Yes	General	9	0
	EE	Expired	Opt-in	No	Limited	5	0
	LV	Expired	Opt-in	Yes	Limited	6	0
	LT	Expired	Opt-in	No	General	6	0
	BG	Extended	Opt-in	Yes	General	12	6
	HR	Extended	Opt-in	No	General	15	12
	CZ	Expired	Opt-in	Yes	Limited	6	0
	HU	Extended	Opt-out	Yes	General	15	6
	PL	Expired	Opt-in	No	Limited	6	0
	RO	Extended	Opt-in	Yes	General	12	3
	SI	Introduced	Opt-in	Yes	General	12	0
Core countries of the euro area	AT	Expired	Opt-in	Yes	Limited	10	7
	BE	Extended	Opt-in	Yes	Limited	13	3
	FR	Expired	Opt-in	Yes	General	4	0
	DE	Expired	Opt-in	Yes	Limited	3	0
	LU	Expired	Opt-in	No	Limited	6	0
	NL	Extended	Opt-in	No	Limited	15	9
Mediterranean countries	CY	Expired	Opt-in	Yes	General	9	0
	GR	Expired	Opt-in	No	General	9	6
	IT	Extended	Opt-in	Yes	Limited	10	4
	MT	Extended	Opt-in	Yes	General	12	6
	PT	Extended	Opt-in	Yes	General	18	12
	ES	Extended	Opt-in	Yes	Limited	16	11

Source: Data retrieved from ESRB and MNB

4. The payment moratorium in Hungary

4.1. Data used

The MNB has detailed, transaction-level data to assess the potential effects of the payment moratorium. Granular data are available from several sources on the debtors participating in the payment moratorium and on the loans and certain demographic characteristics of households and corporate clients. Based on the data sources available, our analysis can provide an accurate overview on the effects of the use of the payment moratorium in Hungary.

The following data sources were used in the analysis of clients entering the payment moratorium and their exposures (*Figure 5*):

– *Central bank credit register:* an anonymised database reported by credit institutions on a monthly basis, covering more than 500 attributes of the credit stock and the related borrowers and collateral. However, the current income of borrowers are not included in the credit register, so it does not provide direct information on the current vulnerability of households.

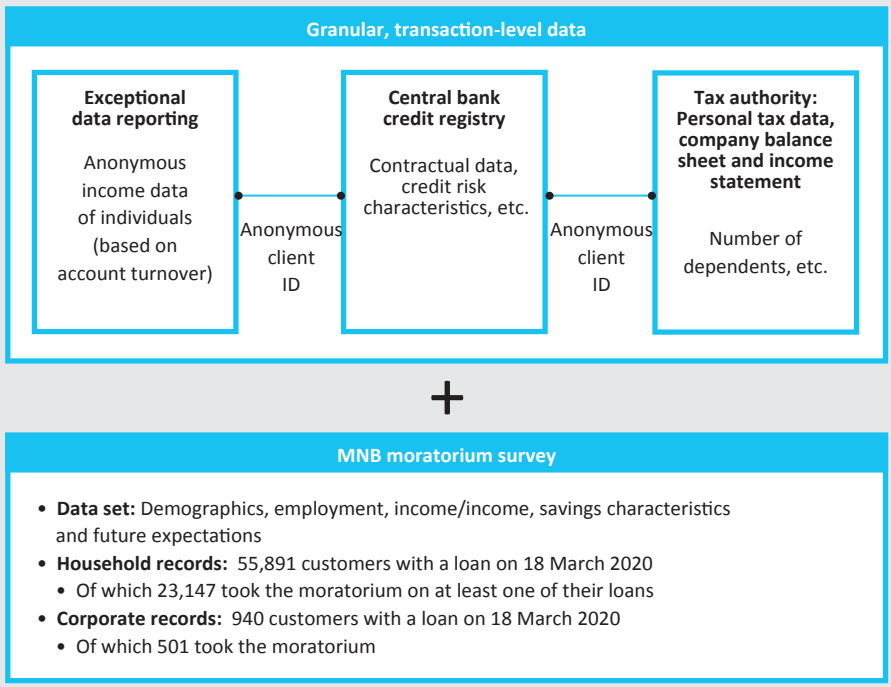
– *Data on tax returns and contributions received from the National Tax and Customs Administration of Hungary:* anonymised data on the income of natural persons having loans, provided by the tax administration pursuant to the decree of the MNB on reporting obligations.[4] However, the disadvantage of data based on personal income tax returns is that they are received by the MNB with a considerable delay. Currently, the 2018 data are available from the database of the National Tax and Customs Administration. The client-level data can be linked to the credit register database of the MNB.

– *Extraordinary bank reporting:* Within the framework of reporting, the banks have provided the MNB, on an anonymised basis, the amount of wages credited to the accounts of bank clients having wages credited in December 2019, broken down by months for the period of January to July 2020. The anonymous client-level data can be linked to the credit register database of the MNB, thus providing an opportunity to carry out a deeper analysis of the income losses resulting from the coronavirus pandemic.

– *MNB questionnaire survey:* By means of an online questionnaire survey, we obtained information on the financial situation, shock resilience and expectations of bank clients. Nearly 56,000 households and 1,100 corporate debtors completed the survey. In addition to the granular data assets of the MNB, the data retrieved from the questionnaire are a good supplement to the assessment of the employment, savings situation and expectations of clients.

[4] Decree No 41/2020. (XI. 18.) of the Governor of the Magyar Nemzeti Bank on the reporting obligations for the central bank information system to be fulfilled primarily in the relation to carry out the basic tasks of the Magyar Nemzeti Bank

Figure 5
Central bank data and their sources enabling the monitoring of clients who have used the payment moratorium



Source: MNB

4.2. Payment moratorium in Hungary

In response to the coronavirus pandemic, on 18 March 2020 the Hungarian government announced a payment moratorium on all payment obligations arising from the loans of households, non-financial corporations, financial enterprises and investment funds, effective until 31 December 2020. Based on the payment moratorium, all loan repayments disbursed until 18 March 2020 were automatically suspended until the end of the year without a separate request, but debtors had the right to continue repaying their loans. Clients will not be relieved of the amount of delayed interest accumulated during the moratorium, which shall be repaid after the expiry of the moratorium, annually, in equal instalments over the term of the loan. In accordance with the provisions of the detailed legislation,[5] the instalment shall not increase after the expiry of the moratorium, and the remaining maturity of the contracts will be extended instead. As delayed interest payments will not be

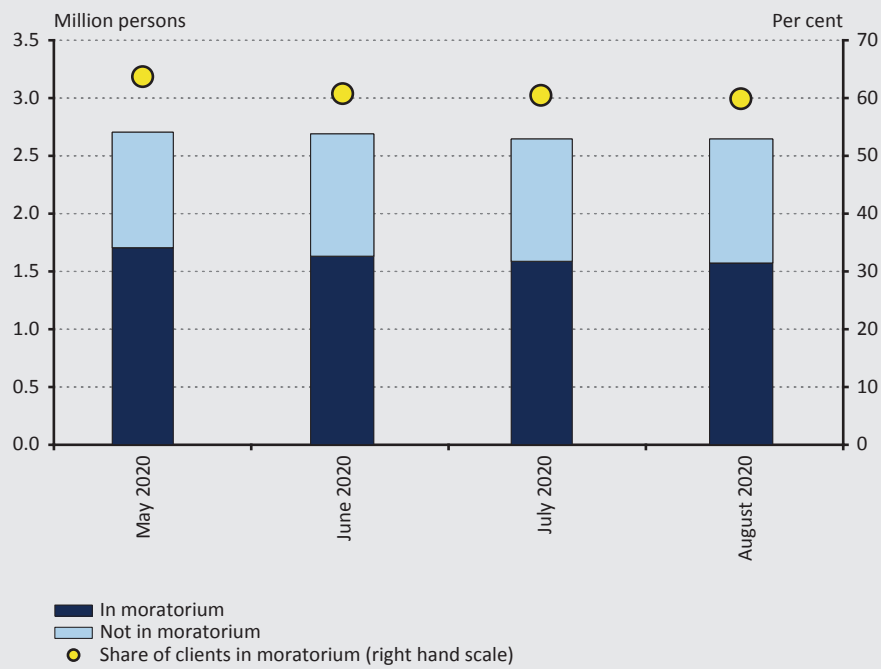
[5] Act LVIII of 2020 *on the transitional rules related to the termination of the state of danger and on the epidemiological preparedness.* Hungarian Official Journal (Magyar Közlöny), No. 144, 3653–3751.

capitalised during or after the moratorium, debtors can restructure their loans on favourable terms, thus bridging their potential liquidity difficulties.

4.2.1. Characteristics of retail clients participating in the moratorium and the affected loan portfolio

According to the first reporting on the use of the moratorium in May 2020, a total of *1.6 million debtors*, i.e. about 60 per cent of the 2.7 million bank retail clients[6] (including debtors and co-debtors) eligible for the moratorium, *took part in the payment moratorium* for at least one of their loans in the first months of the moratorium period (*Figure 6*). Recently, the proportion of clients entering the payment moratorium has not changed significantly, and thus their characteristics are presented here based on the latest data for August 2020 available at the time this study was written.

Figure 6
Proportion of retail bank clients entering the payment moratorium among all clients eligible for the moratorium

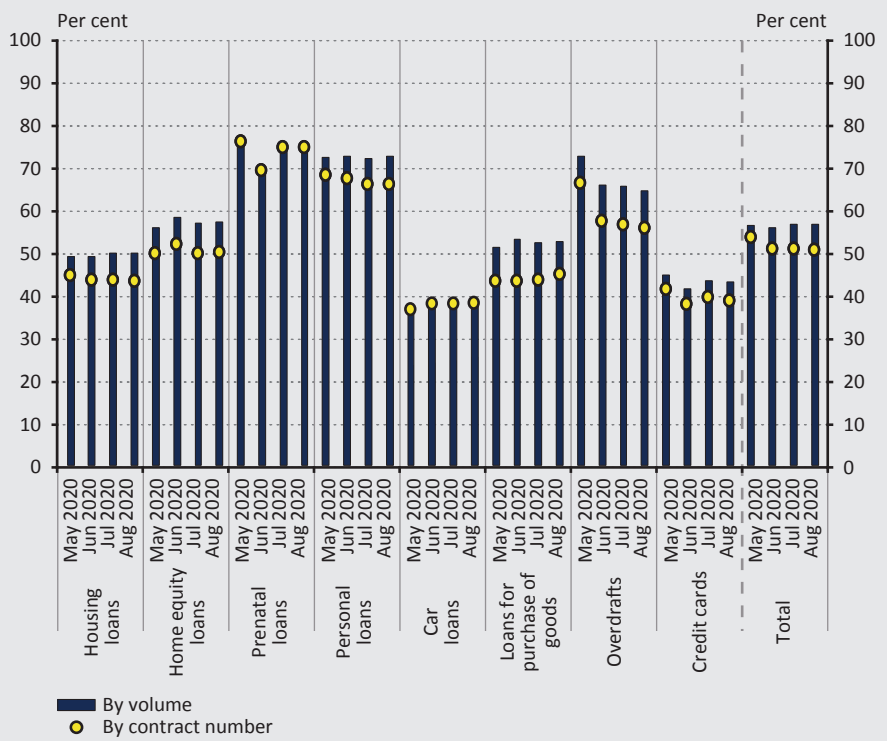


Note: Both debtors and co-debtors participating in the moratorium on at least one of their loans were taken into account as clients entering the moratorium. Only credit institutions sector and natural persons as debtors (excluding sole proprietors and primary producers).

[6] In this study, we examined the loan portfolio of the credit institutions sector regarding natural persons as debtors, excluding primary producers and sole proprietors.

According to the latest data of August available at the time this was written, about 1.5 million retail clients in the credit institutions sector entered the moratorium for nearly 1.7 million loan agreements and a loan portfolio amounting to HUF 3,700 billion. By retail customers the moratorium was mostly used for typically higher-interest, shorter-term personal loans. It can be explained by the potentially higher interest rates on consumer loans and the generally low consumer willingness to repay consumer loans. Regarding the use of the moratorium, the proportion of participation in the case of volume-based distributions is similar to the number of contracts (*Figure 7*), which indicates an even distribution of loans under moratorium.

Figure 7
Proportion of loans under moratorium by type of loans

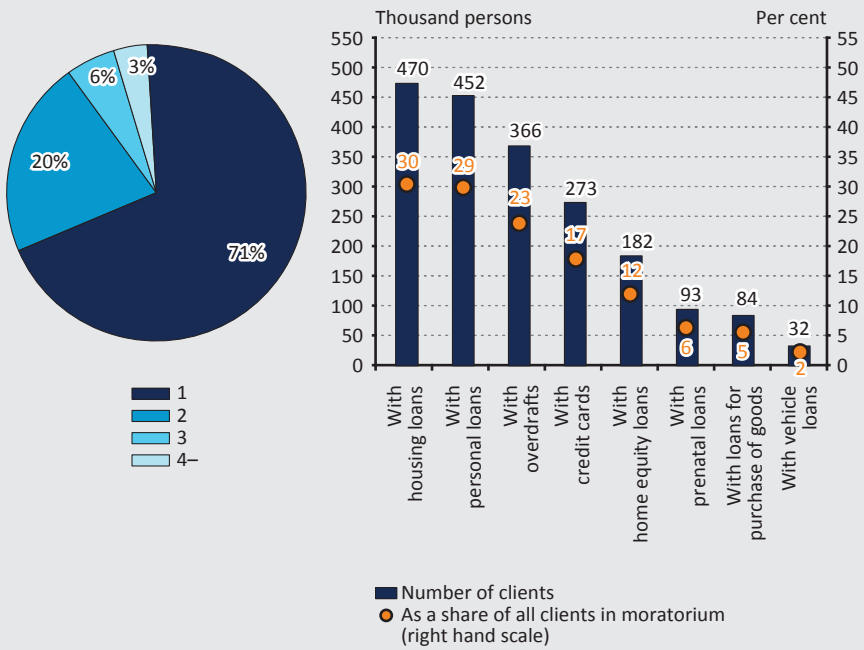


Note: Only credit institutions sector and natural persons as debtors (excluding sole proprietors and primary producers). The proportion of the moratorium on the prenatal baby support loans also includes data on the suspension of repayments related to having children.

Nearly three quarters of the debtors entering the payment moratorium exercised the option for one loan (around 1.1 million persons), one-fifth for two loans (around 300,000 persons), and one-tenth (around 150,000 persons) for three or more loans. Nearly 500,000 people (including debtors and co-debtors), representing one third

of the clients entering the payment moratorium on at least one of their loans, have a housing or personal loan (or both), and about one fifth had an overdraft facility or a credit card. About 93,000 clients, or 5 per cent of the clients participating in the payment moratorium, had a prenatal loan (*Figure 8*).

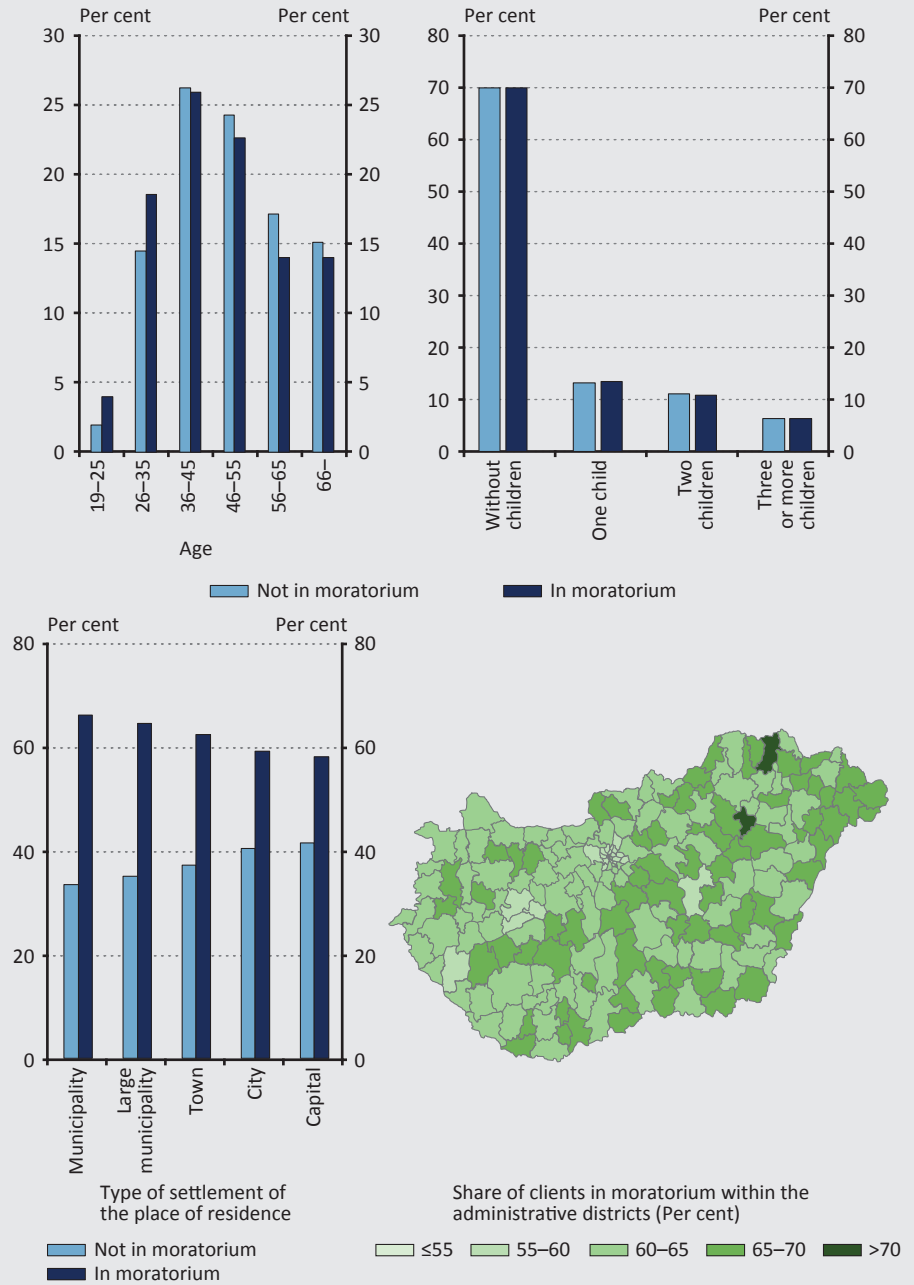
Figure 8
Number and proportion of bank clients that entered the payment moratorium for at least one of their loans by the number of (left panel) and the type of (right panel) their loans in moratorium



Note: Data for August 2020. Clients participating in the payment moratorium may have more than one loan at the same time, so the data in the right hand chart are not mutually exclusive. Banking sector and natural person debtors only.

Based on the demographic characteristics of clients entering the payment moratorium, it can be concluded that those with reduced shock resilience were more likely to use the programme. The proportion of clients entering the payment moratorium under the age of 35 was 23 per cent, higher by approximately 6 percentage points than clients not in moratorium. The payment moratorium is used by a larger proportion of clients living in smaller municipalities, and in the less developed eastern and southern districts of the country as well, which may be explained by the lower levels of development and employment in these areas. Based on the available data, unlike the age and the place of residence, the number of children raised in the household did not substantially affect participation in the payment moratorium (*Figure 9*).

Figure 9
Distribution of bank clients by participation in the payment moratorium and age, as well as number of children and place of residence (August 2020)



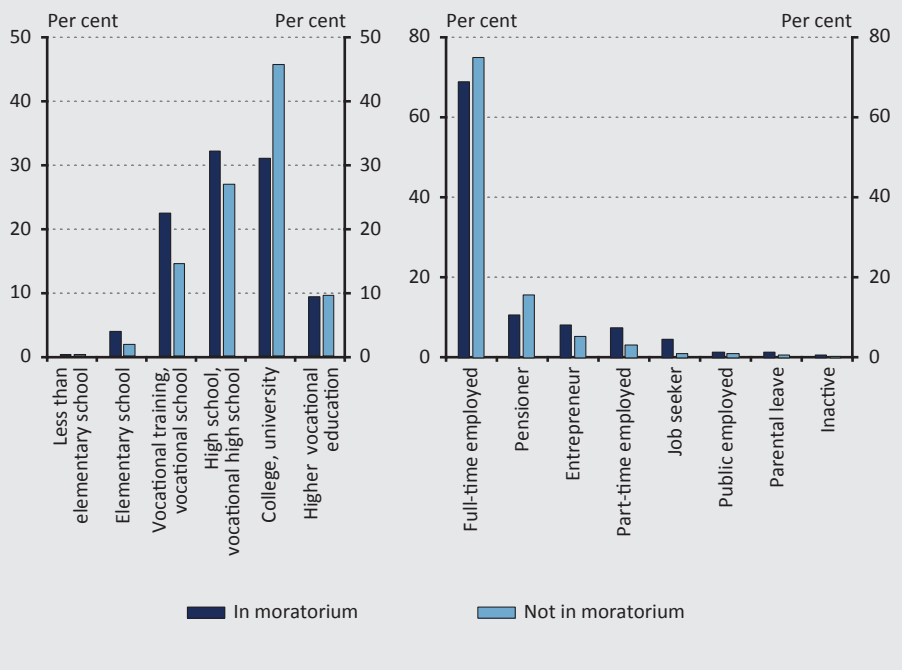
Note: Only banking sector and natural persons as debtors (excluding private entrepreneurs and small-scale agricultural producers).

The income and labour market characteristics of clients entering the payment moratorium also confirm that a higher proportion of those with reduced shock resilience used the payment moratorium. The proportion of clients participating in the payment moratorium is higher among those who have low educational attainment, or are part-time workers or job seekers, and are more indebted and have low savings (*Figure 10*).

– *Educational attainment:* According to the MNB survey, among those entering the payment moratorium, the proportion of clients who have at most a secondary school degree, considered as low educational attainment, is 61 per cent, while this proportion is 44 per cent among clients who did not enter the payment moratorium.

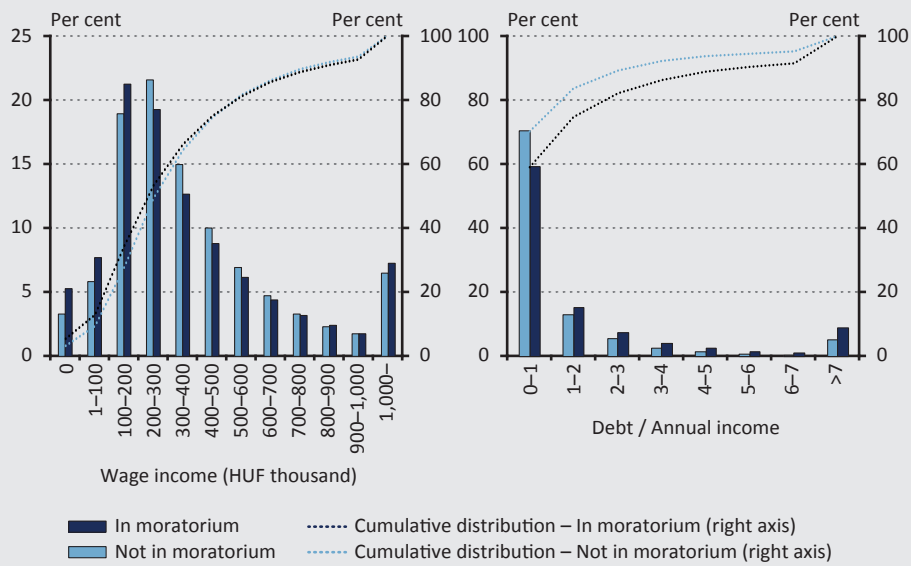
– *Status of labour market:* There are four times as many unemployed and twice as many part-time workers among the clients who entered the payment moratorium, compared to debtors who did not participate in the payment moratorium.

Figure 10
Distribution of bank clients by use of the payment moratorium and level of education attained by the highest earning people of the household and their labour market status (August 2020)



– *Income situation:* Based on the extraordinary reporting ordered by the MNB, the income of bank clients at the sector level was similar among the clients entering the moratorium and those opting out of it (*Figure 11*). The median income fluctuated between HUF 260,000 and 280,000 in net value for both the clients entering the moratorium and those opting out of it. At the same time, taking into account the indebtedness of clients, it becomes apparent that the proportion of clients with higher debt and thus a higher instalment, compared to their income, is more significant among those entering the payment moratorium (*Figure 11*). More than 220,000 clients, approximately 14 per cent of clients participating in the payment moratorium, have debt exceeding their annual income more than four times, which is nearly twice the value of clients who opted out of the payment moratorium. Highly indebted clients were more likely to stay in the payment moratorium, as *Gaffney – Darren* (*2020*) also established using data for Ireland.

Figure 11
Bank clients according to their use of the payment moratorium, income and indebtedness in relation to their income

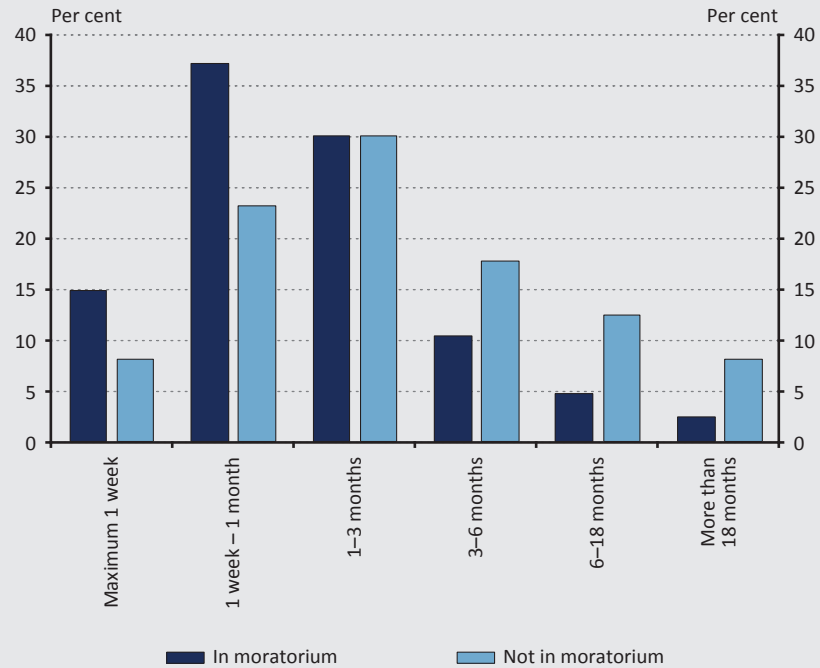


Note: The total debt/annual income ratio was examined among bank clients with wage credits in December 2019 based on their debt stock in August 2020 and the annualised average of their average wage credits in the second quarter of 2020. Regarding the total debt of the clients, in case of co-debtors the total debt of all parties assuming a joint commitment was considered.

– *Savings:* According to their self-assessment, households remaining in the payment moratorium have lower savings compared to households that opted out of the payment moratorium. Of households in the payment moratorium, 83 per cent have sufficient savings for up to three months, while this proportion is lower by

21 percentage points, amounting to 62 per cent in case of performing households (*Figure 12*).

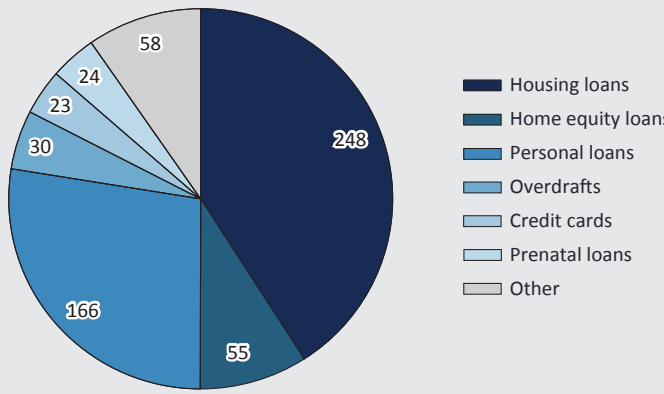
Figure 12
Savings of households remaining in and opting out of the payment moratorium



Note: Question: If all members engaged in paid employment lost their jobs in your household, for how long would the household be able to maintain its current standard of living?

We estimate that the payment moratorium will improve the liquidity position of households by approximately HUF 580–620 billion until the end of 2020, i.e., by 1.2–1.3 per cent of 2019 GDP. The liquidity effect of the moratorium stems mainly from the instalments of mortgage loans amounting to about HUF 300–310 billion and personal loans of about HUF 160–170 billion remaining with households (*Figure 13*). In addition to personal and mortgage loans, the potential instalment savings from overdraft and credit card debts are also significant. According to the current market practice, it results in HUF 50–55 billion of savings, assuming 5 per cent repayment of outstanding capital amount per month. In 2020, the amount remaining with households due to the payment moratorium contributed significantly to mitigating the potential negative effects of the coronavirus pandemic.

Figure 13
Estimated liquidity impact of the payment moratorium by product type (HUF billion)



Note: Only banking sector and natural persons as debtors (excluding private entrepreneurs and small-scale agricultural producers). In the case of prenatal loans, the liquidity effect of the payment moratorium also includes the effect of the suspended repayment due to having children.

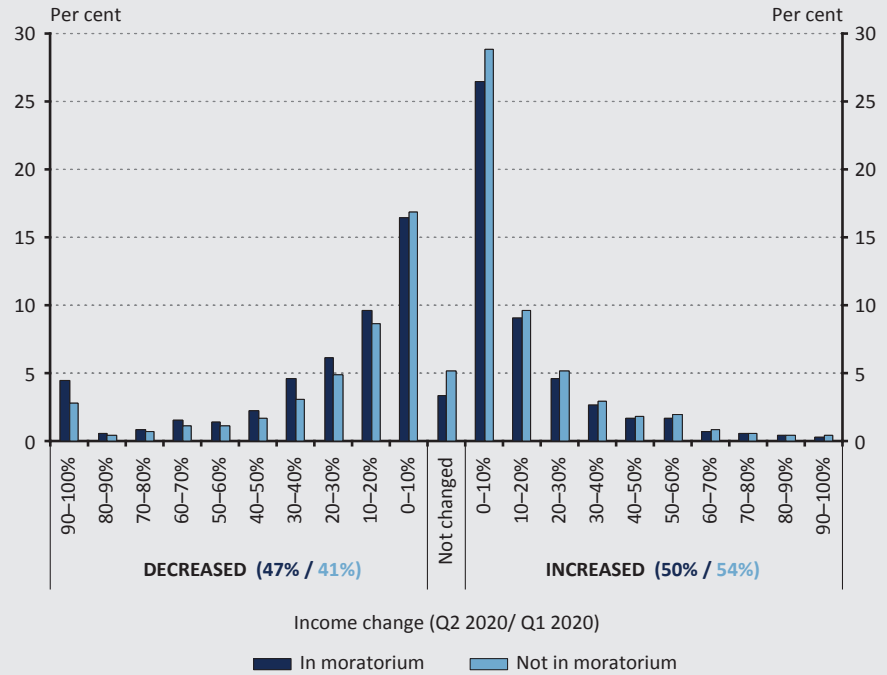
Source: MNB

4.2.2. Potentially vulnerable retail clients

In order to identify the potentially vulnerable client segment directly impacted by the effects of the coronavirus pandemic, we examined the changes of the income situation and labour market position of the clients, and their responses in the questionnaire on their vulnerability to the pandemic.

Compared to the first quarter of 2020, the average monthly income of approximately 47 per cent of clients not continuing their repayment obligations decreased to some extent in the second quarter of 2020 (*Figure 14*). The income of one third of these clients decreased by more than 30 per cent. Thus, according to our estimation, *240,000 household debtors using the payment moratorium can be considered vulnerable* based on changes of their income situation.

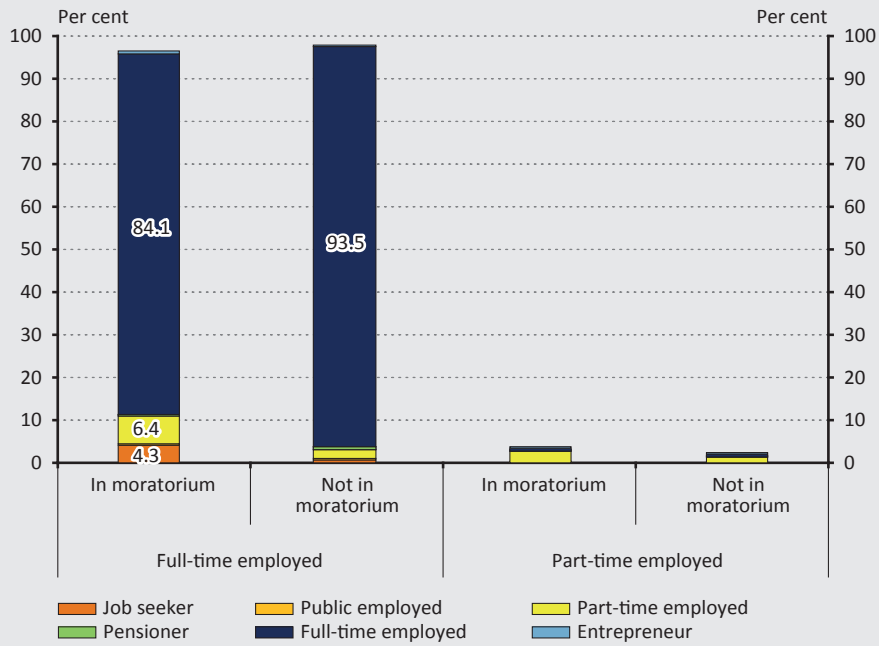
Figure 14
Distribution of bank clients based on quarterly change in the average wages credited to their bank accounts between the first and second quarter of 2020



Note: Only banking sector and natural persons as debtors (excluding private entrepreneurs and small-scale agricultural producers). An estimate prepared based on the income information of bank clients with wages credited in December 2019.

According to the MNB's survey, in more than 11 per cent of households entering the payment moratorium the highest earning member worked as an employee in February 2020, and their labour market status has deteriorated since then, while the same proportion for those opting out of the payment moratorium was 3 per cent. Of the 11 per cent of debtors using the payment moratorium and experiencing deteriorating labour market conditions, 7 percentage points became part-time employees, 4 percentage points became job seekers and 0.5 percentage points became public sector employees (*Figure 15*). As a result, our estimate shows that around *180,000 clients entering the payment moratorium can be considered financially vulnerable* due to the deterioration in their labour market status.

Figure 15
Changes in the current labour market status of full-time and part-time employees in February 2020 (compared to the total number of employees in February 2020)



According to the MNB's survey, more than 53 per cent of households staying in the moratorium expect repayment difficulties in 2021 (*Figure 16*). Nearly three quarters of them claimed that they would already face repayment difficulties in the absence of a payment moratorium. However, a significant proportion of them defined themselves as households with potential repayment difficulties despite their unchanged or rising income, which draws our attention to the occurrence of moral hazard. Therefore, maintaining a broad moratorium over the long term is expected to increase default risks in the future. Based on the survey, almost one third of clients expecting repayment difficulties and using the moratorium claimed to have a significant decrease in their income, and thus *a group of about 270,000 people may be considered vulnerable* according to their self-assessment. Two thirds of this vulnerable client group (*Figure 17*), or *180,000 clients could maintain their current standard of living for up to a month, so they can be considered particularly risky.* This ratio is significantly higher compared to the proportion of households with no significant savings observed in previous years. According to *Boldizsár et al.* (*2016*), about 40 per cent of households have no significant assets.

Figure 16
Distribution of households using the moratorium according to their expectations of repayment difficulties and changes in their income

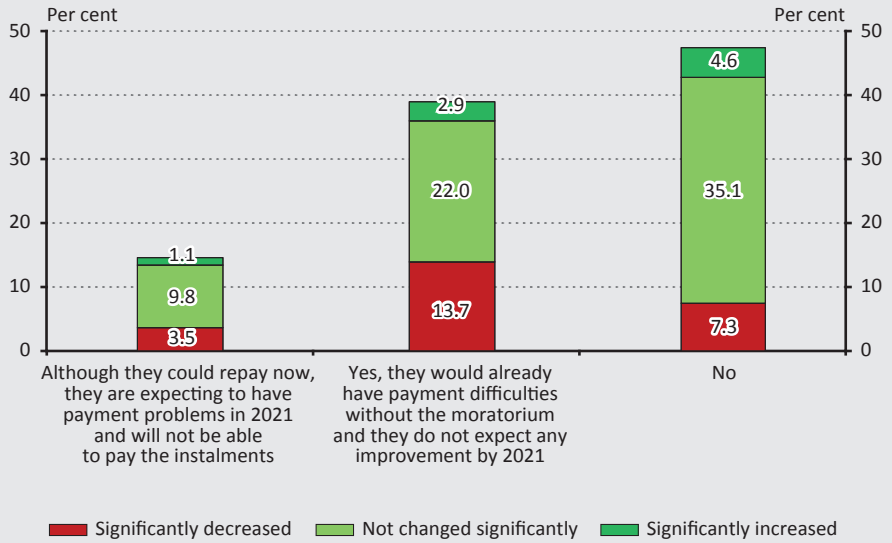
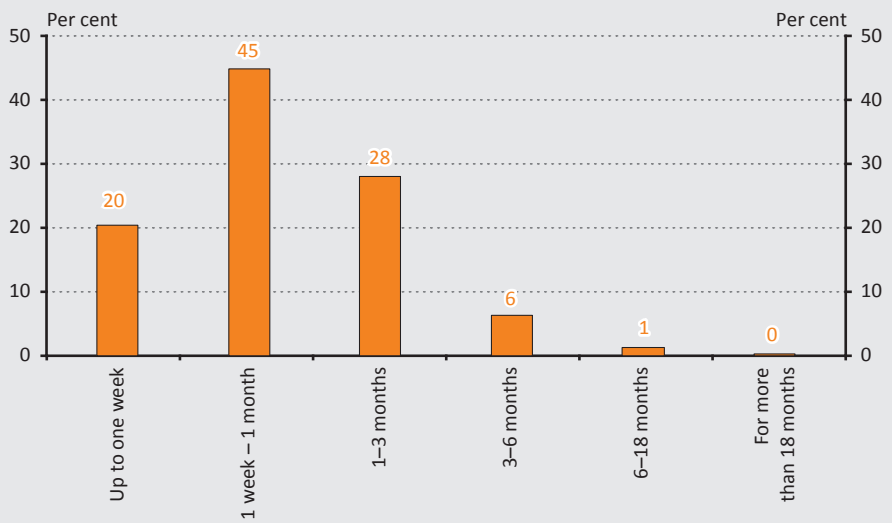


Figure 17
Distribution of the savings of households using the moratorium and claiming to have repayment difficulties in the absence of a moratorium, supposing an event when all members in paid employment lost their jobs



Note: Question: If all members engaged in paid employment lost their jobs in your household, for how long would the household be able to maintain its current standard of living?

All in all, the possibility of the moratorium was used by a larger number of clients who were more vulnerable in terms of demographics, income and wealth. The estimated group of potentially vulnerable household clients directly impacted by the effects of the coronavirus pandemic accounts for around 180,000–270,000 people.

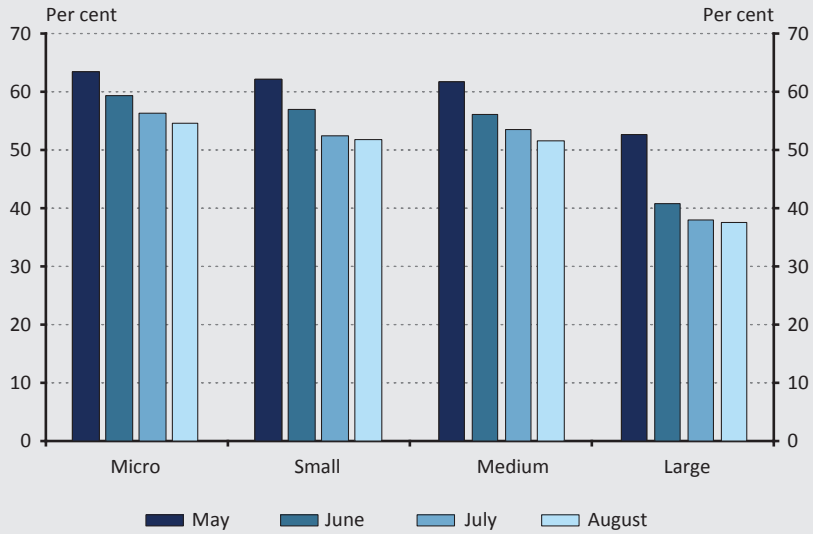
4.2.3. Corporate segment

Based on the data from August 2020, use of the moratorium in the corporate segment, as a proportion of the outstanding loan portfolio, amounted to approximately 40 per cent, i.e. HUF 3,700 billion in the credit institution sector and affected nearly 50,000 companies. Our whole corporate analysis applies to the credit institution sector; the loan portfolio under moratorium belonging to non-credit institutions can be estimated at about HUF 600 billion. During the analysed period, from May to August, use of the moratorium among corporate clients fell by about 10 percentage points. This may be partly due to the fact that with the end of the first wave of the coronavirus, some companies may have decided to continue the repayment of their loans again due to the lower level of uncertainty and rising demand. Despite the lower utilisation, by the end of 2020 the payment moratorium is estimated to have improved the liquidity situation of companies by about HUF 1,100 billion, i.e. by 2.3–2.4 per cent of 2019 GDP.

The size of the company has a significant effect on use of the moratorium, as a smaller proportion of larger enterprises opted for the moratorium (*Figure 18*). Micro-companies and SMEs participated in the moratorium for more than half of their transactions during the analysed period, while the scope of large enterprises entering the moratorium was 10–15 percentage points lower.[7] Among loans with outstanding amounts above HUF 1 billion, use of the moratorium was still 12 per cent lower in June and almost 10 per cent lower in August than in the case of loans with outstanding amounts below HUF 1 billion. Of the contracts participating (outstanding loan portfolio) in the moratorium, 45 per cent (20 per cent) are micro-companies, 23 per cent (18 per cent) are small companies, 14 per cent (24 per cent) are medium-sized companies, and 18 per cent (38 per cent) are large companies.

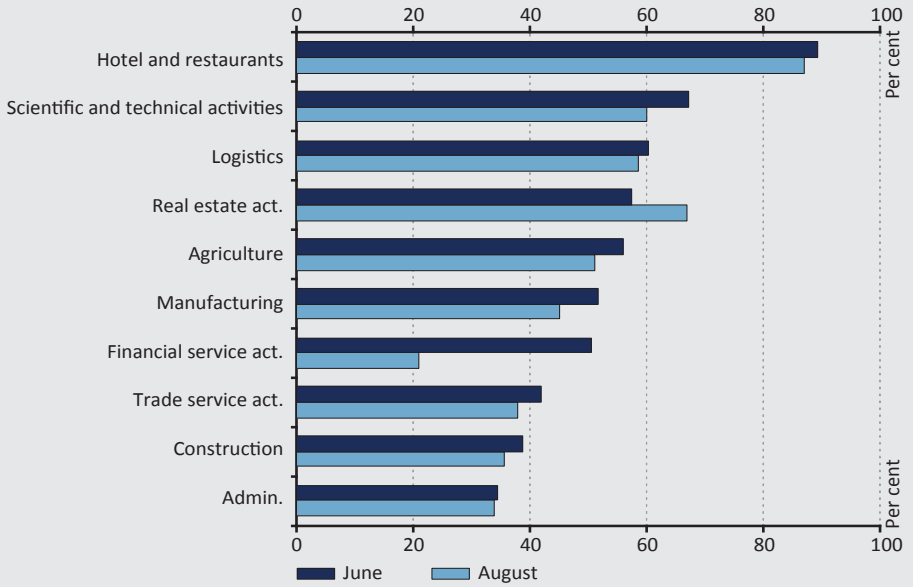
[7] A higher participation of SME clients in the moratorium in Ireland was also observed by *Duignan and McGeever* (*2020*).

Figure 18
Proportion of the loan portfolio affected by the moratorium according to the size of the requesting company



The ten sectors with the largest loan portfolios account for about 94 per cent of the corporate loan portfolio and show higher variability in terms of participating in the moratorium (*Figure 19*). The hotel and restaurant sector has the highest proportion, with above 85 per cent of clients participating in the moratorium. This high utilisation rate is likely to be linked to the negative effects of the coronavirus pandemic on the real economy and the quarantine measures affecting this sector the soonest and most directly; therefore, the moratorium could provide immediate aid to companies operating in this sector to address their liquidity problems. The moratorium was used the least in the construction and administration sectors, where it remained below 40 per cent in both June and August. In the manufacturing industry, which has the largest loan portfolio and accounts for almost one quarter of the total loan portfolio, use of the moratorium is similar to the population mean, i.e. 52 per cent in June and 45 per cent in August. Based on the geographical distribution, there are smaller and larger deviations in the utilisation of the moratorium at the county level, but the aggregate ratios regarding use in Budapest and outside of Budapest are in accordance with the population mean.

Figure 19
Proportion of clients staying in moratorium in the sector with the ten largest loan portfolios in June and August

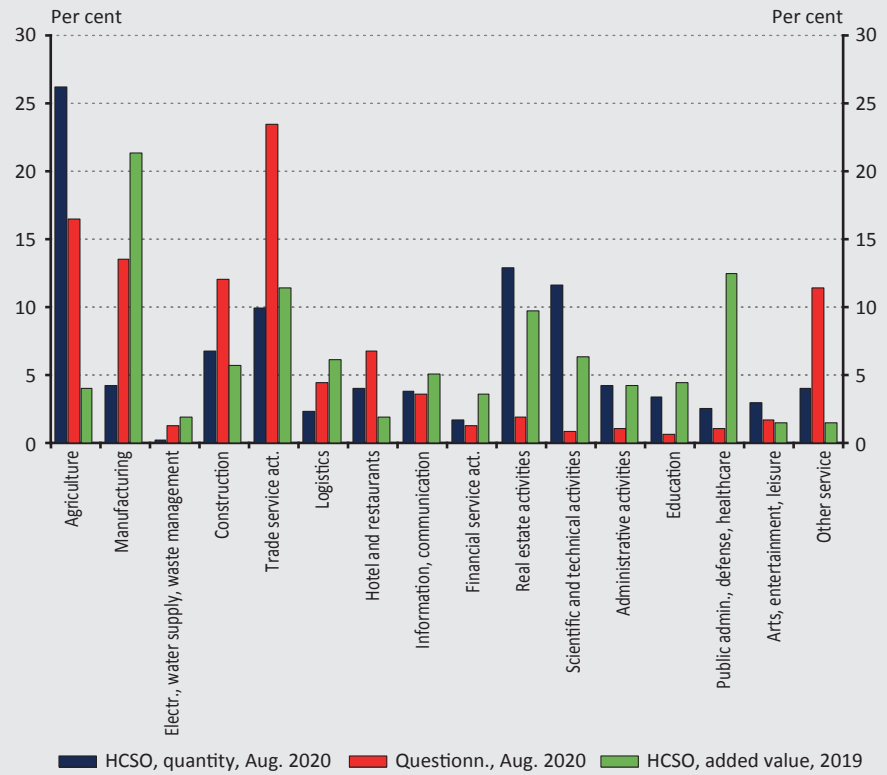


Note: Newly issued loans between July and August are not included.

The findings of the MNB's questionnaire survey also confirm the above mentioned characteristics of corporate debtors participating in the moratorium. The questionnaire was completed by a total of 1,165 corporate debtors, of which 940 responded to the question on the use of the moratorium ("Do you apply the payment (repayment) moratorium valid until the end of 2020 for any of the company's existing loans?"). 501 companies participated in the moratorium, while 439 companies decided to continue repayments, and thus our analysis was carried out on these companies. The sectoral distribution of the responding companies differs slightly from the actual data reported on the contribution to GDP and the number of companies, too (*Figure 20*). According to the actual data from August 2020, although 26 per cent of registered enterprises operated in the industry of agriculture, forestry and fishing[8] and 4 per cent of 2019 GDP was related to this industry,[9] in the survey 16 per cent of the responding companies were related to this industry. In spite of the limited sectoral representativeness, the share of the responding companies participating in the moratorium shows road correspondence with the population mean, as 501 companies entered the moratorium for at least one of their loans, corresponding to a 53 per cent utilisation rate.

[8] Number of registered enterprises by industry – GFO'14. https://www.ksh.hu/docs/eng/xstadat/xstadat_infra/e_qvd019a.html. Downloaded: 20 November 2020.
[9] Value and distribution of gross value added by industry (1995–). https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_qpt002d.html. Downloaded: 20 November 2020.

Figure 20
Distribution of companies and registered enterprises responding to the questionnaire survey by industry within the analysed industries



Note: N=940.

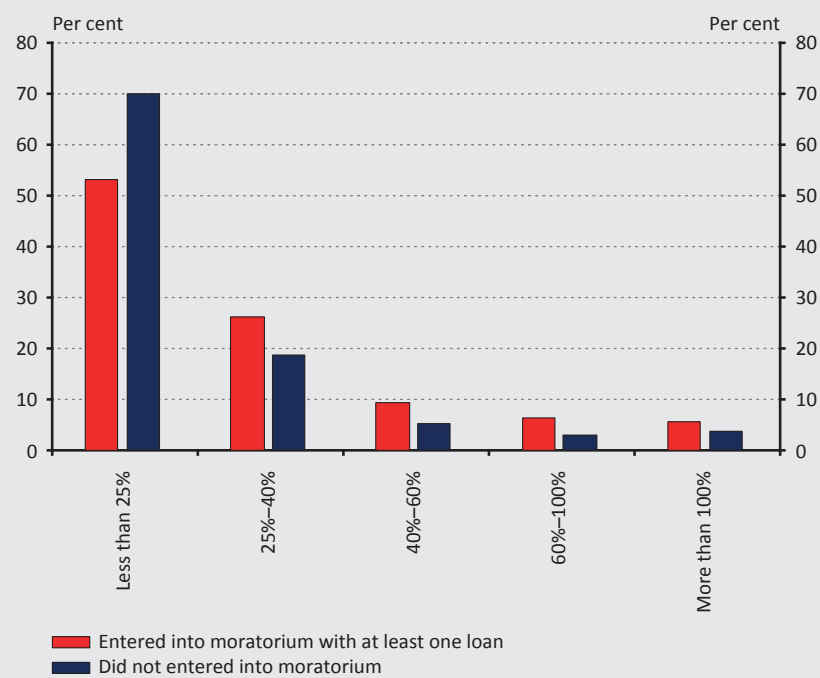
Source: MNB questionnaire survey, Hungarian Central Statistical Office (see footnotes 9 and 10)

According to the questionnaire, the moratorium provided significant help for companies in tackling their temporary liquidity problems, as 30 per cent of companies participating in the moratorium responded that they could not have repaid their loans, and another 40 per cent stated that they could have only partially repaid their loans if they had not participated in the moratorium. Most companies used the funds freed up to cover their temporary liquidity goals: almost two thirds chose this option in the questionnaire survey, while less than 30 per cent of companies indicated all other goals separately (investment, savings/reserves, wage payments).

According to the survey, companies participating in the moratorium were relatively more indebted and expected a more significant decline in average revenue in 2020, which was further supported by the fact that they tended to operate in industries more impacted by the negative economic consequences of the pandemic.

Of the surveyed companies, 61 per cent responded that their outstanding borrowing on 18 March 2020 was below 25 per cent of their annual revenue in 2019, 23 per cent responded that it was between 25–40 per cent, and 17 per cent responded that it exceeded 40 per cent. Among companies participating in the moratorium, the share of low-debt companies was only 53 per cent, while the share of companies opting out of the moratorium with outstanding borrowing below 25 per cent of their annual revenue in 2019 was 70 per cent (*Figure 21*). The share of companies entering the moratorium was already higher, i.e., 26 per cent belonged to the value of 25–40 per cent, while among companies opting out of the moratorium, this share was only 19 per cent. An even higher proportion of more significantly indebted companies with borrowing amounting to at least 40 per cent of their revenue in 2019 participated in the moratorium: 21 per cent of companies entering the moratorium can be classified here, while the share of companies opting out of the moratorium was slightly more than half of this, as 12 per cent of these firms can be considered significantly indebted.

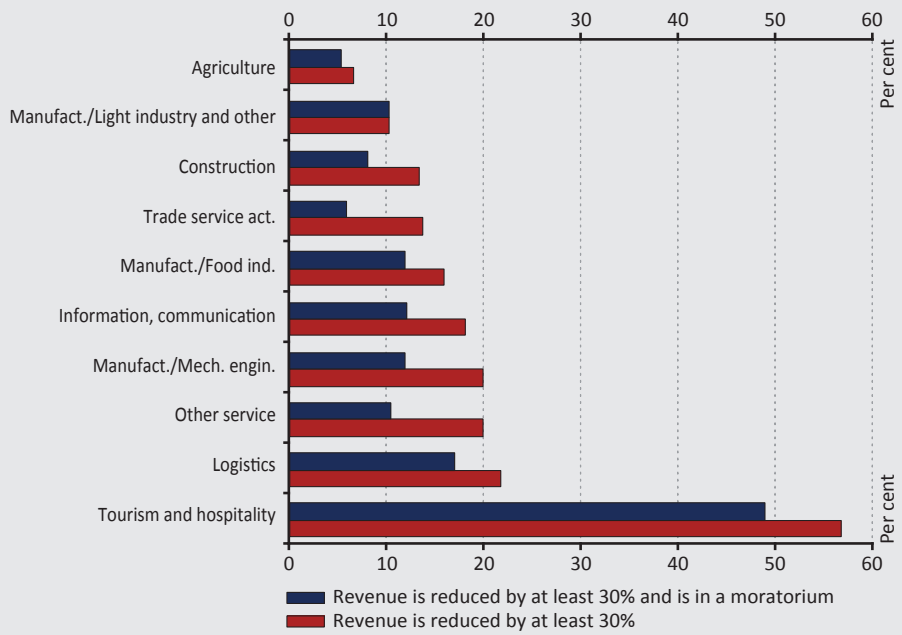
Figure 21
Distribution of companies entering and opting out of the moratorium in the questionnaire survey by outstanding loans in proportion to their sales revenue in 2019



Note: N=940, of which 501 companies benefited from the moratorium for at least one loan, while 439 did not.

According to the questionnaire survey by the MNB, *almost one in five companies claimed to have a significant decrease in sales revenue in 2020*. When the moratorium was introduced, 18 per cent of companies with a loan said they expected this year's sales to be at least 30 per cent lower than last year due to the economic effects of the pandemic. Companies participating in the moratorium foresaw a larger decline in revenue in 2020 than those opting out of the programme. While 24 per cent of those participating in the moratorium expect their incomes to fall by at least 30 per cent this year compared to last year, the same ratio for companies continuing repayments is only 12 per cent. At the same time, a significant proportion of companies participating in the moratorium do not expect their revenue to drop: 34 per cent of them indicated no change or an increase. However, this proportion was significantly higher, at 53 per cent, for those opting out of the programme. The tourism and hospitality sector has been hit hardest by the pandemic: one half of these companies expected to experience at least a 30 per cent decrease in sales in 2020 (*Figure 22*). Within the sector, almost all companies with a significant drop in revenue benefit from the moratorium, and there are only a few exceptions.

Figure 22
Proportion of companies losing at least 30 per cent of their revenue in 2020 compared to the proportion of all respondents, distributed by sectors



Note: Total number of respondents with loans in the indicated sectors: N=838, of which losing significant percentage of their revenue: 145. Total number of respondents with loans and participating in the moratorium in the indicated sectors: N=444, of which losing significant percentage of their revenue: 96.

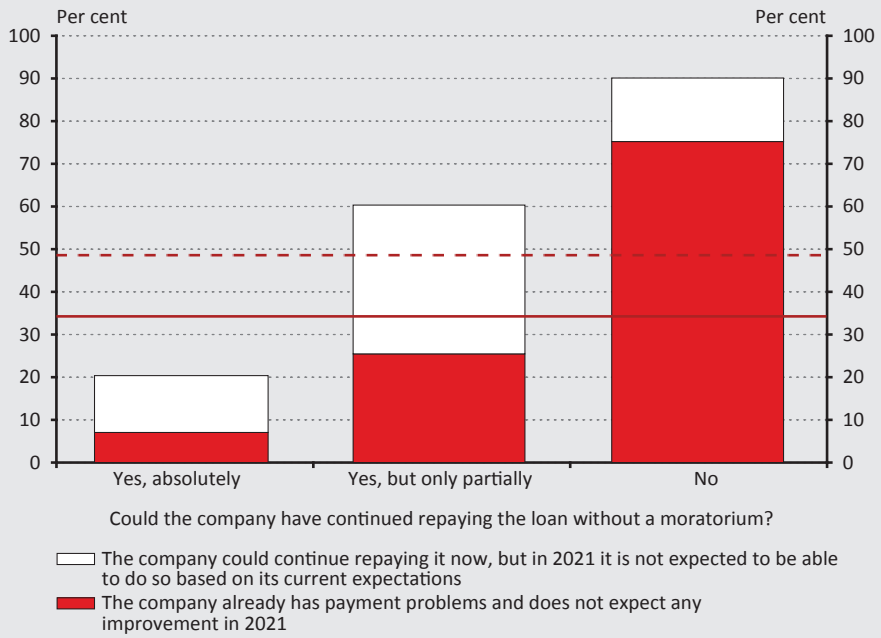
4.2.4. Moratorium in vulnerable industry sectors

In the Financial Stability Report published in May 2020, the MNB identified the sectors most exposed to the negative effects of the coronavirus crisis. The sectors immediately affected on account of the pandemic and the related measures, shutdowns, restrictions and isolation efforts (for example, the entire tourism and hospitality industry sector) were classified as directly vulnerable. Subsectors affected by second-round effects from the containment measures, such as the decline in aggregate demand (e.g. passenger vehicle manufacturing) were classified as indirectly vulnerable (See *MNB* (*2020b:73–76*) for detailed classification). Similar to March 2020, the data from August showed that the loan portfolio of companies operating in vulnerable industries accounted for roughly one third of the total loan portfolio, with their use of the moratorium being higher than average. Companies operating in a vulnerable sector typically have fewer employees compared to the general number in the corporate sector. Among companies operating in vulnerable sectors, the weighting of small- and medium-sized enterprises was above the population mean.

Within the vulnerable sectors, we assessed companies as being particularly risky where the liquidity situation (personnel costs/funds>0.5) and indebtedness (debt/EBITDA>1 or negative) are relatively stretched and they participated in the moratorium. *One tenth of the total corporate exposure is considered to be particularly risky in relation to vulnerable sectors.* Due to the protracted pandemic situation, some of the companies operating in sectors with less direct or indirect exposure to the coronavirus may also have problems repaying loans after the end of the payment moratorium. Therefore, the loan portfolio of companies operating *in non-vulnerable sectors* but which are in a significantly tight financial position (debt/EBITDA>4 or negative and personnel costs/funds>2) and are participating in the moratorium was also *identified as risky*, accounting for *6 per cent of the total corporate loan portfolio*. All in all, the particularly risky loan portfolio accounts for 15–20 per cent of the corporate loans of credit institutions, which is similar to the data in July (cf. MNB *2020c: 31–32*). According to the MNB's survey, *a similar ratio* can be identified *for the risky loan portfolio* (*Figure 23*): *19 per cent* of the 940 companies responding to the questionnaire *said they would not be able to repay at present and do not expect improvement in the future*, and another 12 per cent of companies said they would be able to repay at present, but based on their current expectations of turnover and revenue, they will not be able to in 2021. According to the questionnaire survey, among the companies participating in the moratorium, we can clearly distinguish the ones which are in need of a moratorium or the ones which are only utilising it: three out of four companies which entered the moratorium and experienced more serious liquidity problems in the spring claimed that they are still having repayment difficulties and do not expect any improvement in the future. Of the companies which claimed they would be able to

fully perform in spring but are still participating in the moratorium, only 20 per cent expect repayment difficulties now or in the future. The high degree of persistence in the current situation and expectations may be due to the specific nature of the coronavirus situation: the quarantine measures introduced in spring in relation to the virus situation affected each sector to a different extent, mostly depending on whether the sector is able to operate via digital platforms and teleworking. The prospects of each sector may be strongly influenced by the continuation of maintaining physical distance, so the extent and pace of sectoral recovery may show significant differences.

Figure 23
The relationship between payment difficulties and creditworthiness



Note: Among the 501 companies benefiting from the moratorium, the proportion of companies using the moratorium and claiming to have repayment difficulties (in the future) is indicated with a (dashed) red line. The figure shows respondents with payment difficulties, the remaining respondents did not have a repayment problem at the time of completing the questionnaire and did not expect this in the future.

4.3. Effects of the payment moratorium on the banking sector

4.3.1. Profitability

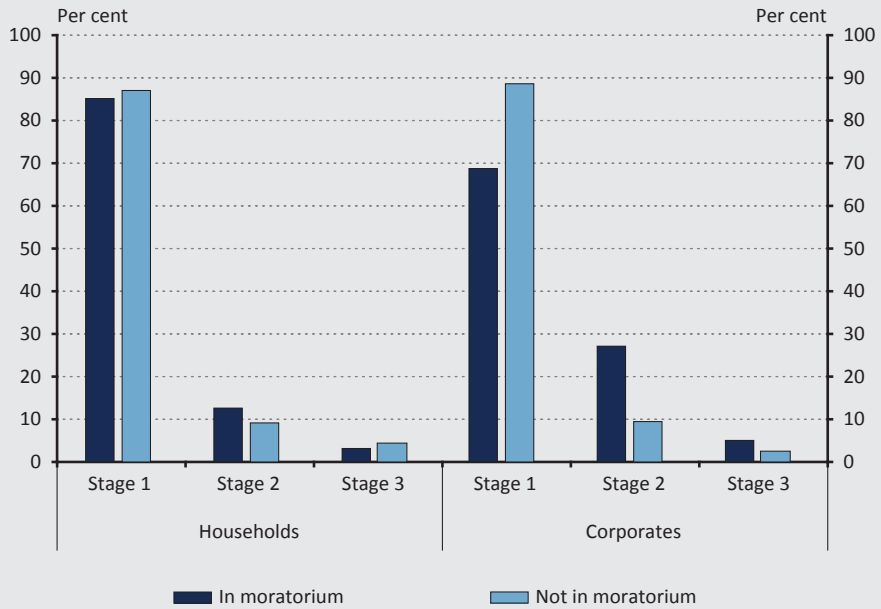
The payment moratorium was able to provide significant excess liquidity to market participants at a moderate cost. Under the legislation on the payment moratorium, the interest due during the moratorium period is not capitalised, but the accrued interest, together with the instalments due in the remaining term, shall be paid after

the expiry of the payment moratorium annually, in equal instalments over the term of the loan. At the same time, however, the banking system is suffering losses due to the decrease in present value. According to our estimates, the payment moratorium may have caused banks a loss of about HUF 25–30 billion in 2020, based on the utilisation data in August. At the same time, the realised loss is partially offset by the decreasing credit risk due to the moratorium, the slower rate of deterioration in portfolio quality and the general stimulus effect of the moratorium on the economy. However, maintaining a moratorium without a confirmed need may increase the moral hazard of customers over the long term, which could lead to long-term losses for the actors in the banking system.

4.3.2. Loan loss provisioning

Excessively long-term availability of a payment moratorium may obscure the real repayment capacity of clients and render prudent loan loss provisioning more difficult for credit institutions. Examining the distribution of loan portfolios in terms of impairment categories (see *Figure 24*), it can be concluded that in the retail segment, loans under the moratorium and loans outside the moratorium do not show a significant difference. Handling retail loan portfolio independently from the moratorium in terms of impairment classification suggests that the payment moratorium may mask the real repayment capacity of clients over the longer term, and that an actual need for loan loss provisioning will only arise later, after the expiry of the moratorium. The payment moratorium has a larger influence on banks' assessment of changes of corporate credit risk than on retail exposures. In the case of companies, it can be observed that credit institutions categorised the loan portfolio in moratorium as higher credit risk to a greater extent. This may be explained by the fact that banks have more information on the credit risk of more closely monitored corporate clients, and that companies are generally more active in approaching their creditor bank in the event of repayment problems. However, the credit risk of clients participating in the payment moratorium in the corporate segment can only be assumed to be an estimate with significant uncertainty, and major corrections may even be required after the moratorium.

Figure 24
Distribution of loan portfolios entering or opting out of the moratorium by client segment and impairment classification (August 2020)



5. Extension of the payment moratorium

The prolonged duration of the coronavirus pandemic and its re-intensification experienced from September 2020 further worsened the economic prospects and necessitated the introduction of further containment measures. In order to counteract the potential negative economic effects of the protracted pandemic, the Hungarian government decided to extend the payment moratorium by 6 months for loans disbursed by 18 March 2020. According to the government's decision, the payment moratorium will remain in effect until 30 June 2021 under the same conditions for debtors which entered the payment moratorium, while debtors which opted out of the moratorium shall inform their creditors of their intention to use the payment moratorium by written or electronic form.

Assuming that the participation rates of the payment moratorium in August are maintained for the entire 6-month period of the extension, the measure may provide approximately HUF 1,100–1,200 billion of excess liquidity for the debtors in moratorium. According to our estimates, household clients benefit from about HUF 420–460 billion and corporate customers from about HUF 680–740 billion of excess liquidity remaining with economic actors. Consequently, the payment

moratorium may leave about 2.3 per cent of 2019 GDP to market participants in 2021, thus alleviating their liquidity difficulties and helping to restore economic activity as early as possible.

Similar to the measure in 2020, the extension of the moratorium will have an adverse effect on bank profitability due to the change in the present value of loans. The six-month extension may result in an additional loss of approximately HUF 10–15 billion for banks, due to the decreased present value of loans. Nonetheless, the potential loss can be offset by the adequate capital position of the banks. The MNB also supported the lending capacity by releasing capital requirements with a number of measures.

However, the vast majority of the loan portfolio expected to participate in the extension of the payment moratorium will no longer be subject to the preferential loan loss provisioning rules, which will result in an additional obligation of loan loss provisioning by the banks. Based on the recommendation of the European Banking Authority (*EBA 2020b*) and the information provided by the MNB,[10] the extension of the moratorium taking effect after September 2020 is considered to be new payment rescheduling. In the case of the moratorium extension taking effect after September 2020, the duration spent in moratorium shall be examined in terms of loan loss provisioning, and the preferential treatment defined by the EBA would not apply to exposures that have been in moratorium for more than nine months between March 2020 and June 2021. As a result, the transactions involved in the extension of the moratorium, which have been in moratorium for more than nine months in total, would need to be re-categorised to the Stage 2 category of loan loss. Our estimates show that the loan portfolio affected by the extension of the payment moratorium may call for loan loss provisions in the amount of up to HUF 200–300 billion in 2021. The MNB, however, informed the institutions in an executive circular[11] that it is considered to be a good practice to re-categorise exposures as restructured and classify them to Stage 2 only if a deterioration in the client's financial data is observed or if no information is available on its financial position; consequently, the ultimate impact may be expected to be lower. The MNB is also supporting the strengthening of the resilience of the banking system and the maintenance of its lending capacity with a number of additional measures: it is temporarily not sanctioning non-compliance with the capital conservation buffer and Pillar II Guidance lifted the capital buffer requirement for systemically important institutions, and it has decided to postpone the annual review of the systematic risk buffer in 2020.

[10] https://www.mnb.hu/sajtoszoba/sajtokozlemenyek/2020-evi-sajtokozlemenyek/hitelbovules-biztonsagos-mukodessel-jegybanki-utmutatas-a-bankoknak
[11] https://www.mnb.hu/letoltes/vezetoi-korlevel-az-ifrs-9-standard-alkalmazasaban-a-makrogazdasagi-informaciok-felhasznalasarol-es-a-hitelkockazat-jelentos-novekedeset-jelzo-tenyezokrol.pdf

6. Conclusions

The payment moratorium introduced in Hungary as one of the first of its kind proved to be a widely used measure in an international comparison to address the liquidity difficulties caused by the coronavirus pandemic. The payment moratorium provides temporary relief for the repayment obligations of debtors, increases their disposable income and thus their savings, which can be used to offset the economic shocks caused by the pandemic. In addition to its widespread availability, the measure in Hungary was accompanied by a high level of participation, as about 60 per cent of the approximately 2.7 million retail bank clients, i.e. 1.6 million debtors, and roughly 50,000 businesses, half of all corporate debtors eligible for the moratorium entered the moratorium having at least one loan.

In our study, we reviewed the demographic, income and wealth characteristics of clients participating in the moratorium based on the uniquely detailed data available to the MNB. As a result, we found the shock resilience of clients entering the moratorium is lower than the ones opting out of the moratorium. In terms of income and labour market characteristics, there is a higher proportion of clients participating in the moratorium with a low level of education, part-time employees or job seekers, more indebted clients and clients with a low amount of savings. Based on the previously discussed findings, the existence of a moratorium has an adverse selection effect in itself, as those clients in need of a moratorium have a higher rate of using the programme than those who have adequate repayment capacity in spite of the effects of the pandemic. The tendency can also be observed in the case of corporate loans: companies more indebted or operating in sectors that are more exposed to the economic difficulties caused by the coronavirus have largely gathered under the protective shield of the moratorium.

At the level of the national economy, households and companies participating in the payment moratorium are estimated[12] to receive about HUF 1,700 billion of excess liquidity by the end of 2020 due to the moratorium, which amounts to 3.5–3.7 per cent of 2019 GDP. Of this figure, the household segment accounts for about HUF 580–620 billion, or 1.2–1.3 per cent of 2019 GDP. The liquidity effect on households is mainly due to mortgage instalments amounting to HUF 300–310 billion and personal loan instalments amounting to HUF 160–170 billion, which is complemented by repayments on other, less common types of loans. In the corporate segment, the liquidity effect of the moratorium can be estimated at HUF 1,100 billion by the end of the year, i.e. 2.3–2.4 per cent of 2019 GDP. Similar effects are expected after the extension of the payment moratorium. According to our estimate, the six-month extension of the moratorium could leave about

[12] Calculated on the basis of the proportion of loans under moratorium in each month, and assuming no change from September in the proportions of August.

HUF 420–460 billion in excess liquidity for households and HUF 680–740 billion for companies. The payment moratorium has thus made it possible to implement a significant economic recovery measure at the level of the national economy. In addition, the payment moratorium provides more time for debtors to make the necessary adjustments, so it can be assumed that the potential credit loss to be realised after the moratorium may remain modest compared to the financial crisis in 2008.

However, the picture is nuanced by the fact that, in terms of the credit risk characteristics of clients entering and opting out of the moratorium, in addition to vulnerable debtors, a significant proportion of less vulnerable debtors also participated in the moratorium. On the one hand, a prolonged moratorium which goes beyond the pandemic will increase the interest accrued during the moratorium and be repaid later. On the other hand, it may obscure the real repayment capacity of clients, and a long-term suspension of repayment may even worsen their payment discipline in the future. The general nature of the moratorium may further increase moral hazard, which may reduce the repayment willingness of some debtors upon maintaining the measure in the long term. All of these factors may contribute to the fact that the portfolio of problematic bank loans may rise after the end of the moratorium, worsening the lending capacity of banks due to the incurred losses and thus increasing risks to financial stability. Over the longer term, these may be partially mitigated by proactive restructuring of loans and, in the case of consistently non-performing exposures, by sales to winding-up institutions.

On the creditors' side, the payment moratorium and the extension thereof may cause a limited and manageable direct loss of approximately HUF 35–45 billion until June 2021, due to the change in the present value of loans. The extension of the moratorium may also result in a need for loan loss provisioning of up to HUF 200–300 billion on the banks' side due to the relevant accounting rules. At the same time, the programme can partially mitigate potential losses of creditors by maintaining the portfolio quality and improving the overall business environment. Furthermore, the domestic banking system had enhanced resilience compared to the previous crisis, and was in an adequate capital and liquidity position when hit by the coronavirus pandemic, which helps to manage any losses that may arise. Overall, the benefits of the moratorium realised during the crisis may far outweigh its potential risks, and accordingly in our view, the measure has proven to be an effective and efficient crisis management tool. However, it is important to emphasise that the moratorium is a temporary tool to mitigate the effects of exogenous shocks to the economy. Prolonged solutions which go beyond the epidemic situation may lead to significant moral hazard and financial stability problems.

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Corporate Credit Risk Modelling in the Supervisory Stress Test of the Magyar Nemzeti Bank*

Gergő Horváth

As a regulatory and decision-supporting tool, the stress test framework plays an important role in assessing the vulnerability of the domestic financial system and the individual institutions. Consequently, continuous development of the models used in parameter estimation is of crucial importance. This study aims to improve credit risk loss estimation, which is one of the most important components of the supervisory stress test framework, by making the estimation of corporate default and transition probability more accurate. The study is based on a client-level default database, which contains various actors in the Hungarian banking sector and covers an entire economic cycle (2007–2017). It is unique as it introduces a uniform stage classification rule for determining the transition probabilities which attempts to create harmony with domestic institutions' loan loss provision policies under IFRS 9. Based on the research findings, it can be concluded that – relying on a wide-ranging set of macroeconomic and client-level variables – it is possible to separate corporate debtors with adequate discriminatory power as well as to estimate point-in-time probability of default (PIT PD) and transition probabilities at the corporate level relevant in terms of the stress test, and thus to approximate the loan loss provisioning requirement arising in a stress situation. Of the factors capturing the cyclical nature of corporate default probability, the state of the labour market and the income position of the household sector were identified as the main determinants by the study.

Journal of Economic Literature (JEL) codes: G21, C51, C30

Keywords: stress test, credit risk, PD, bank, corporate loans, forecast

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* 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. Introduction and literature review

The turbulent events in the spring of 2020 and the unexpected economic effects of the containment measures taken due to the coronavirus (COVID-19) pandemic once again highlighted that it is absolutely necessary to operate a toolkit that can assess the shock resilience of the institutions constituting the foundation of the financial system with suitable accuracy and also prevent the evolution of individual or even systemic risks. Significant progress has been made in this field, as stress test methodologies have become embedded in central bank and supervisory work routines around the world. One of the first efforts was the stress test launched in 2009 by the Fed, i.e. the US central bank, which now assesses the riskiness of bank holding companies through two separate programmes (CCAR and DFAST) (*Flannery et al. 2016*). Another example is the European decision-makers' initiative, as a result of which the European Banking Authority (EBA) published its first exercise in 2011,[1] since which time key European institutions are assessed every two years (*EBA 2011*). The strength of these international stress tests is based on two main factors: 1) *credibility*, i.e. the achievements are acknowledged not only by the banking industry in a narrow sense, but also function as valuable sources of information for the market, investors and the broader public as well; 2) *transparency*, i.e. the process of formulating the applied methodology and disclosing the results are based on an information base that is sufficiently detailed for everybody. Assessing bank risks using scenario-based stress testing has also featured in domestic practice for a longer time *(Banai et al. 2013)*. Initially, it appeared in a macroprudential role, before becoming embedded in the supervisory work as well by way of an expansion of the ICAAP subjects starting from 2018 onwards. In Hungarian practice, the annual supervisory stress test serves as the basis for the capital guidance to be determined, in addition to the capital requirement (P2G, i.e. Pillar 2 Capital Guidance).

A supervisory stress test is a complex quantitative procedure, which – in accordance with international guidelines (*EBA 2018*) – is designed to assess individual institutions' resilience to a severe, but plausible macroeconomic shock. The scenario applied in domestic practice stems from one of the alternative scenarios defined by the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB). Over the two-year time horizon of the test, the impact of the economic downturn on banks' profitability and capital position can be deduced from a simulated realisation of credit, market, operational and counterparty risks. Based on the evaluation of the results of the stress test (primarily the fall in the simulated CET1 ratio), the MNB decides on the minimum free capital level to be maintained above the TSCR

[1] Although in the previous two years a stress test was also conducted by the Committee of European Banking Supervisors (CEBS), which can be considered the predecessor of the EBA, its representativeness (the number of institutions involved) and transparency (the detailedness of findings) were far lower that of the stress tests organised by the EBA (*CEBS 2009*).

(Total SREP Capital Requirement) and the capital buffers that guarantee safe and sustainable operation in an unfavourable economic situation as well. Although the capital guidance is not a part of the capital requirement quantified during the ICAAP review and should also not be considered as a capital buffer, in all cases its violation results in close monitoring of the capital position of the given institution (*MNB 2021*).

Nevertheless, it is worth looking at these exercises not only as regulatory tools, since the function of the stress test is much wider-ranging. In times when traditional approaches prove to be less efficient, the stress test also functions as means of decision-making support. Therefore, it is highly recommended to implement these methodologies in credit institutions' own internal decision-making procedures as well for the early identification of risks and for taking proactive measures. At the same time, practical experience shows that, for the time being, actors in the domestic banking sector fail to extensively utilise the opportunities inherent in the stress test as a tool to efficiently recognise the risks of banking operations. While reliable credit risk information and its historical availability cause the main problem in the case of smaller institutions, development capacity tends to be the main bottleneck for larger institutions. Therefore, it is an important objective to continuously improve the existing methodologies as well as to support the development of best practices and their sharing with market participants, which may facilitate the strengthening of risk awareness in the domestic banking sector.

This study aims to improve credit risk loss estimation, which is one of the most important components of the stress test framework, by making the estimation of corporate default and transition probability more accurate. In past years, various relevant domestic research works attempted to estimate the probability of bankruptcy, but they differ from this study in various respects (goal, sample, approach).

The research by *Bauer and Endrész* (*2016*) carried out on a sample of Hungarian companies that use double-entry bookkeeping also emphasised – in addition to company-specific information – the importance of including macro factors in the models to capture the level of risk, especially during a crisis period. They also reach the important conclusion that explanatory power can be significantly increased by taking into account heterogeneity by firm size and the non-linearity of firm characteristics. Similar research was carried out in the same year by *Banai et al.* (*2016*), who analysed the features of the SME sector. Their findings coincide with the conclusions of *Bauer and Endrész* (*2016*), but it was a step forward that the

dependent variable of their model was based on data originating from the Central Credit Information System (CCIS), and not on the legal definition of bankruptcy.

However, driven by a different set of objectives, other authors paid less attention to the factors that determine time-varying heterogeneity, as their analysis focused on the estimation of the long-term probability of bankruptcy, in which respect the position on the cycle curve is considered a less relevant factor. In that respect, from the domestic literature the studies by *Inzelt et al.* (*2016*) as well as *Dabi and Szenes* (*2020*) are worth mentioning. While the former intended to use the estimation of the long-term probability of bankruptcy to create a robust monitoring framework, the latter were interested in elaborating a single capital requirement calculation method. Both studies have important value, as they identified several firm-specific variables that have strong business content, the use of which allows for the achievement of strong segmentation power in the case of companies. These main variables are primarily related to debt servicing, liquidity and productivity.

The above also shows that there are certain differences in the domestic literature in terms of the objectives. The closest work to this study is perhaps that of *Lang and Stancsics* (*2019*), who expressly carried out a stress test-oriented analysis using the time series for the period after 2010. The impact of the new IFRS 9 standard already appears in their research, as they created several stage categories with the help of the number of days past due (DPD) recorded for each transaction and then provided an estimation for the transition probabilities by a unique grouping and combining of these categories.

This study seeks to contribute to the literature in various ways. Firstly, it approximates the probability of default by real bank observations, which – as a result of the duration of the sample period – cover not only partial cycles but an entire economic cycle, including its rising and falling branches as well. This enables a more precise estimation, as the revealed correlations can be tested over a wider range of variances. Secondly, from a stress test point of view the research reflects a relevant, point-in-time (PIT) approach instead of capturing the through-the-cycle (TTC) probability of default, also allowing for the identification of time-varying heterogeneity, which often was not explained in previous models. At the same time, it represents a step forward compared to the traditional PD approach, making a proposal for a more precise estimation of transition probabilities that complies with the IFRS 9 rules (and is therefore needed for loan loss estimation) by applying a standard stage2 rating, which better approximates bank practices. Also, in addition to financial indicators that capture macroeconomic and client-level characteristics, it estimates portfolio quality along non-financial variables (ownership structure, type of activity, etc.). These factors together generate the value of the research, since –

as far as we know – in Hungary there is no modelling framework that completely covers the above aspects.

The structure of the study is as follows: *Section 2* presents the modelling framework, with special regard to the data and explanatory variables used. *Section 3* discusses the model selection procedure applied. *Section 4* elaborates on the results of the PD model, discussing how transition probabilities can be estimated within the framework of the stress test. *Section 5* presents the impact of a stressed macroeconomic scenario on the probability of bankruptcy and on the transition probabilities between stages. The conclusions are summarised in *Section 6*.

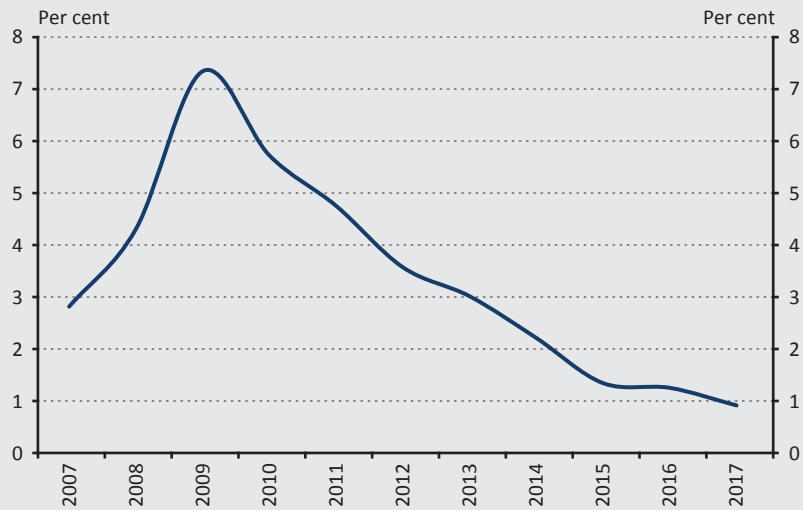
2. Modelling framework

2.1. Data used

The modelling was carried out on a unique, corporate default database, which was created by the MNB within the framework of its supervisory review activity, based on data reported by banks. The database was contributed to by eight of the largest domestic credit institutions according to balance sheet total by delivering bank analytics that contain client-level data of annual frequency between 2007 and 2017 (*Figure 1*). The database used does not contain micro-enterprises that belong to the project and household segment and require more special treatment compared to the sphere of non-financial corporations in a traditional sense.

One of the main advantages of the data provided by banks lies in the relevance of the concept of default. While the common feature of the research studies carried out to date is that they typically tried to approximate default events with bankruptcy and winding-up proceedings, or attempted to capture them with the length of the delay in loan repayment, *in this study the proxies used previously for the estimation of the probability of default are substituted with real bank default events*. Firstly, this is a way to avoid the distortions of estimation results caused by delayed appearance of corporate payment problems due to protracted legal or court procedures, and secondly, it is ensured that with the default criterion all other pieces of information available for banks (e.g. financial position, legislative environment, behaviour features) are included during the rating of the client. Another advantage of the database is the length of the modelling sample period, as banks' data supplies contain good-quality data retroactively to 2007, which means that they cover an entire economic cycle. This is of particular importance, as the primary objective of the modelling is to take time-varying heterogeneity into account.

Figure 1
Corporate default rate in an annual breakdown, based on number of cases



Source: MNB

The database contains a total of 63,772 individual clients and 286,446 observations (by client and year), where 9,987 default events were recorded.

2.2. Explanatory variables

Considering that one of the main objectives of the research is to capture the time-varying heterogeneity of default and transition probabilities, the model relies on a wide-ranging set of macroeconomic variables. The source of the macroeconomic information which is relevant in terms of client quality and non-performance is the set of macroeconomic variables predicted on both the baseline and alternative economic paths by the MNB's economic research departments. The tested variables include the values of gross domestic product (GDP) and its individual components (e.g. exports, imports) calculated at real prices. In addition, variables characterising the state of the household sector (average earnings in the private sector, disposable incomes) and indicators describing the labour market situation (employment, rate of unemployment) are also used. Price-type indicators in a wider sense, such as the consumer price index (CPI), foreign-exchange rate (EUR/HUF) and interest rate (3-month BUBOR), have also been taken into account. In the case of macroeconomic variables, when choosing the functional form, stability was the main criterion. Therefore, all of the variables were included with their stationary transforms, which in practice means the first-order differential or log-differential transformation of the variable. For further information on the variables, see *Table 6* in the *Annex*.

This study intends to exceed the limits of traditional macro stress tests, the common feature of which is that almost exclusively they derive the probability of default of bank portfolios from macroeconomic variables characterising economic cycles. Considering that the granularity of the database used also allows for the application of variables that describe client-level characteristics, both corporate financial indicators and non-financial variables are used in the modelling. Client-level indicators were created from the balance sheet and income statements of the company information database.

Dabi and Szenes (*2020*) identified a strong correlation between certain corporate financial indicators and bank default. In their study, testing nearly 50 variables, the authors came to the conclusion that the probability of default is mostly related to the following five indicators: long-term and short-term liquidity, productivity, leverage and debt coverage. At the same time, it is important to note that the authors were fundamentally interested in the production of a TTC-approach PD, and therefore they deliberately excluded from the examination the cyclical profitability ratios, which may also be important variables of the default probability in a short-term approach.

The modelling is based on the above financial indicators, although it was necessary to amend their composition in line with the objective of this study (to produce a PIT-approach PD). In lieu of the productivity ratio, which has the lowest explanatory power, two profitability ratios also applied in bank practice were added to the list: return on assets (ROA) and profit on sales (POS). Descriptive statistics of the main explanatory variables and the exact definitions of the variables can be found in *Table 5* and *Table 7* in the *Annex*, respectively.

In producing the indicators, the level of detail in the available financial reports is both an important aspect and constraint. Most of the smaller firms are only required to prepare a simplified financial report, with limited information content. Due to the narrow coverage, only indicators that can be found in all of the reports concerned may be included. Although the most important indicators (sales revenue, after-tax profit, liquid assets, liabilities, etc.), which indicate the financial state well, are available this way as well, exploring deeper correlations is limited by the scope of the available data. One partial solution to this is if the examination does not extend to the firms on which no financial information can be found for some reason, or the report is not sufficiently detailed. Considering the representativeness of the estimation and the number of sample elements, this study excludes only those firms that did not submit a financial report in the sample period, while in one case the low number of sample elements of the sector justified the cancellation.[2] Narrowing the

[2] One of the sectors (households' activity as employers), which is less important as far as the whole economy and credit institutions are concerned, contained only one observation, and thus by leaving this sector out we narrowed the number of sample elements to a negligible degree.

sample with the firms that do not have a financial report is also justified because of the estimation of the transition probabilities between the stages, as classifying these firms into stage 2 would not be reliable within the framework of this methodology without the traceability of the financial position. Financial information on the given firm cannot be found in nearly 32,000 cases in the database, meaning that nearly 90 per cent of the total number of elements remains even without these observations.

In addition to the above, the list of variables was expanded to include variables of a non-financial nature as well. Accordingly, the model includes two categorical variables that characterise ownership structure. One of these classifies the companies on the basis of the role of the state, while the other classifies them on the basis of foreign presence into 2 categories each (majority ownership was taken as a basis for the separation of state-owned/market and foreign/domestic firms in both cases). Incorporating the variables is justified by the assumption that the default risk of a company with a well-capitalised ownership background is lower than that of one that is in a similar financial position, but operates under weak control by its owners. Firstly, this may be attributable to the owner's ability to provide help to its affiliates in solving temporary financial problems directly, using its financial muscle, and secondly, indirectly, because of the presence of the owner, actors in the financial intermediary system may also prove to be more committed to the further financing of the company. In the case of foreign-owned domestic companies, often there is a multinational group in the background, and thus these companies may enjoy the advantages of this phenomenon similarly to the companies that are partly owned by the state. Nevertheless, it is important to note that the company information database we used does not contain more detailed information on the identity of the owner, and thus 'nationality' as a collective category may refer to large foreign corporations and private persons alike. Presumably, the favourable effect in the latter case is weaker.

As other studies also indicated, segmentation according to company size may play an important role in the separation of companies according to probability of bankruptcy. Therefore, it may seem obvious that company classification should follow the traditional classification into three groups (micro, SME, large corporation), which is based on the headcount, sales revenue and balance sheet total criteria under the SME Act. At the same time, it must be taken into account that – in parallel with an increase in size – the number of sample elements and the number of negative outcomes declines drastically. Accordingly, there are only a couple hundred observations in the large corporation category. In terms of estimating the probability of default, this may still be an acceptable number, but when decomposing corporate events into stages, in some segments the degree of data loss makes it impossible to prepare well-founded estimations. The study attempts to handle this constraint by dividing the SME segment into two parts (small and medium-sized enterprises) and assigning the subsegments to the segments that are the closest in terms of size. The

category comprising micro and small enterprises as well as the one comprising the actors in the sector of medium-sized and large companies are created accordingly.

Another possible way of grouping companies is classification according to the nature of the activity. The companies in the sample can be classified into 16 whole-economy sections under the NACE and even more divisions. As the number of elements of observations varies across the sections of the national economy, their riskiness is captured with groups created from the divisions. Arranging the individual whole-economy sections in order according to PD and dividing them into three (division1=low risk, division2=medium risk, division3=high risk), a categorical variable can be created that can be used for the purpose of analysis. During grouping, one aspect was that there be a sufficient number of observations in each category, and that in terms of risk level the groups had to be separable as best as possible. For more detailed information on the rating, see *Table 8* in the *Annex*.

Grouping the companies is also possible according to the geographical location of the activity/clientele or the place where the income is generated (domestic or export-oriented). However, in the case of firms that prepare simplified financial reports, the income data related to export activity are not included in the financial statements, and thus in the end we did not use this variable.

In the case of all financial indicators, we used the values of one year earlier (*t–1*). The main reason for this is that the objective of the analysis was to prepare an estimate for the next period, and thus we would like to draw conclusions for events expected in the future from currently available corporate information. Accordingly, we would like to know how a company in a given financial position reacts to a future shock.

The use of financial indicators raises a number of questions, to which other researchers previously called attention as well. In corporate samples, indicators often show extreme values, and fitting may be distorted by the presence of the non-linear correlations also emphasised by *Bauer and Endrész* (*2016*) as well as *Banai et al.* (*2016*). In order to manage these potential problems, instead of raw financial indicators we incorporated their so-called weight of evidence (WOE) values. The essence of the transformation mechanism often applied in credit rating systems is that the continuous variables are classified into groups (bin) on the basis of their contribution to non-performance, before transforming these categories onto a logistic scale using the following formula:

$$\mathrm{WOE}_i = \left[ln \left(\frac{Default_i / Default_{total}}{Non\text{-}default_i / Non\text{-}default_{total}} \right) \right] \cdot 100,$$

where $Default_i$ and $Non\text{-}default_i$ mean the number of non-performing and performing clients, respectively, within the *i*th bin $Default_{total}$ and $Non\text{-}default_{total}$ represent the total number of non-performing and performing clients, respectively.

A detailed methodological description of the transformation of variables is available in the works of *Anderson (2007*), while the calculated WOE values belonging to the individual categories of variables can be found in *Figure 6* in the *Annex*.

2.3. Dependent variable and stage rating

The main target variable of the default rate model is the default event, which – as a binary variable – corresponds to a value of 0 or 1. At the same time, this study also intends to exceed the traditional approach in the sense that it presents a model that is suitable for a direct estimation of stage transition probabilities under the new IFRS 9 standard, in addition to that of the probability of default, allowing for the proper estimation of loan loss levels in the stress test. Accordingly, the binary dependent variable was expanded to include an additional four migration target variables that are relevant in terms of the stress test[3] ($stage_{1-3}$, $stage_{2-3}$, $stage_{1-2}$, $stage_{2-1}$). The transition probabilities were estimated pursuant to the same logic as that of the PD, but through separate equations, using multinomial logistic regression.

Credit institutions must apply the new IFRS principles as of January 2018. The introduction of the standard resulted in a shift in emphasis from incurred losses to expected losses. For the estimation of expected losses, the regulation divides the instruments affected by credit risk into three loan loss categories, assigning different loan loss rules to each category. The categorisation partly corresponds to the previous one, as stage1 contains performing exposures, while stage3 comprises non-performing ones. At the same time, the new accounting principles also introduced the concept of SICR (significant increase in credit risk), which declares that instruments where a significant increase in credit risk is experienced must be treated separately in terms of loan loss, in another category (stage2). The biggest difference between the treatment of the stage1 and stage2 categories is that while loan loss provisioning covering a 12-month expected credit loss is necessary in the case of the former, lifetime provisioning is required in the latter category, which may significantly raise the loan loss levels of credit institutions compared to the past.

Theoretically, there are various solutions for deducing the stage transition probabilities. One of these is the method applied by the EBA as well, i.e. an indirect deduction of transitions from the probability of default. The underlying idea is that the PD can be decomposed into two default transition probabilities, i.e. $stage_{1-3}$ and $stage_{2-3}$. Following that, the other two transition probabilities can even be deduced from the rest with the help of regression correlations based on historical data. At the same time, the transition probabilities may also be directly connected with relevant macro and micro variables, which results in a simpler and clearer estimate. As this is a new subject, few studies have dealt with the estimation of the transition

[3] In compliance with the EBA guideline, in a conservative manner, during stress testing we do not take recovery into account, and thus the estimation of $stage_{3-1}$ and $stage_{3-2}$ does not constitute the subject of this study.

probabilities between stages to date. The model of *Lang and Stancsics* (*2019*) is the latest one, in which the stage categories were identified and created with the help of the number of days past due (DPD). In doing so, they attained the uniform treatment of stage categories across banks, although the application of the number of days past due may result in an underestimation of the real stage2 holdings.

An examination of the loan loss provision policies and stage2 rating principles of 9 leading domestic credit institutions for the period of 2018–2019 reveals that there are major differences across the DPD and actual IFRS 9 classifications. Nearly half of the banks under review reported a multiple of the stage2 holdings rated on a DPD basis, which is a result of the fact that – in addition to the number of days past due – various triggers induce the reclassifications. It can be stated in general that, in addition to the 30+ days of delay, internal client rating or the change in the client's PD as well as the early warning signals of the monitoring system are the most frequently applied aspects. Consequently, in practice even those clients are reclassified into stage2 whose solvency does not imply any perceptible problem (e.g. default in payment), but detectable negative changes which may be reasons for concern occurred in their financial position or economic indicators.

An overview of loan loss provision policies offers further lessons as well. The majority of institutions classify transactions according to rather different sets of criteria within the flexible framework provided for by the accounting rules. Firstly, there are institutions that take the percentage changes in the PD as a basis for reclassification (e.g. a 1.5–2.5-times deviation compared to the base period), but there is also an example for a criterion determined in percentage points, which does not take into account the client's current riskiness, only its absolute change (e.g. a rise of 5 percentage points compared to the base period in the case of a given segment). Secondly, it also happens that under certain rating or PD categories a change is not considered significant, but the exposures are automatically reclassified above a given score/PD level. As a result, in the case of the best clients, more rating category impairments need to take place for a reclassification than in the case of lower-rated clients. Thirdly, the applied numerical criteria (cutpoints) are also different, which also leads to different assessments of clients' riskiness across banks.

The above raise the necessity of 1) standardising the stage2 definitions that are different across banks; and 2) deviating from the DPD-based rating methodology, which is often applied as a simplification, and better approximating the methodology under IFRS 9 in the course of stress test modelling.

As we do not have detailed information on individual banks' client rating systems, and monitoring tools are also not available to us, stage ratings can be determined with the help of the changes in the calculated client PD over time and with the help of the default flag, approximating the bank practice.

The standardised stage rating rules in the model are as follows:

$$\textit{If } D_{it} = 1, \textit{ then } S_{it} = S3;$$

$$\textit{If } D_{it} \neq 1 \textit{ and } [(PD_{it} > 0.02 \textit{ and } PD_{it} \geq PD_{i0} \cdot 2) \textit{ or } PD_{it} \geq 0.15], \textit{ then } S_{it} = S2;$$

$$\textit{If } D_{it} \neq 1 \textit{ and } [(PD_{it} \leq 0.02 \textit{ or } PD_{it} < PD_{i0} \cdot 2) \textit{ and } PD_{it} < 0.15] \textit{ and } S_{it-1} \neq S3, \textit{ then } S_{it} = S1,$$

where S_{it} *and* S_{it-1} is the *i*th client's stage category at *t* and *t–1* points in time, respectively, D_{it} is the *i*th client non-performance flag, where 0 is the performer, 1 is the non-performer, PD_{it} is the *i*th client's probability of default at the *t*th point in time, PD_{i0} is the *i*th client's probability of default in the base period.

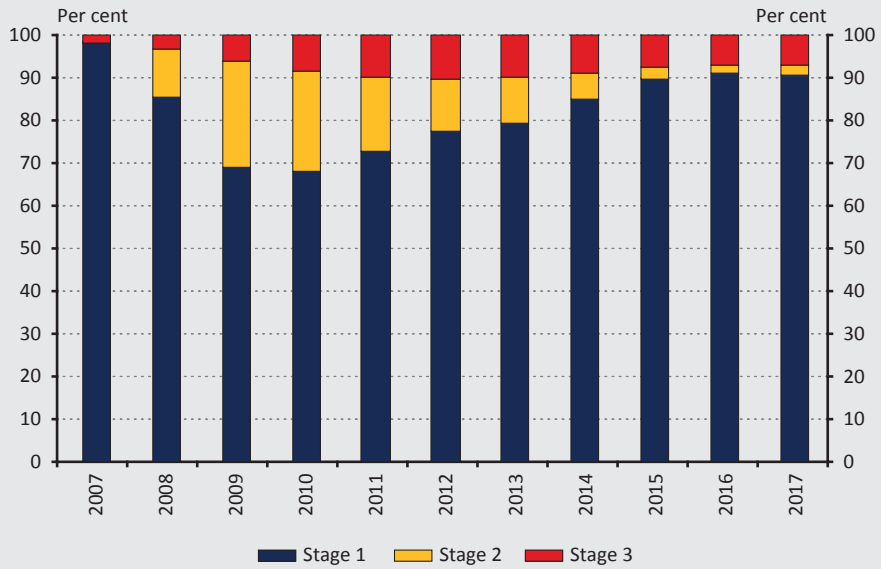
In line with the above rules, a client is reclassified from the best category to stage2 if the given client's PD doubles compared to the base period.[4] At the same time, in line with bank practice, under a specified, low PD level (2 per cent) the model does not consider the increase in credit risk to be significant, but when a certain PD level (15 per cent) is exceeded, clients are reclassified automatically. The assumption behind this is that institutions' normal willingness to take risks is much more conservative than this value, and thus a PD above this level may indicate a significant rise in credit risk compared to disbursement.

According to the rules, migrating is possible in the opposite direction as well, to a limited extent. Transition from stage2 to stage1 is possible if the original conditions of reclassification into the worse category no longer exist. In practice, this means that transition takes place if during the given period the client was not in default and its PD declined to below a pre-determined threshold, or the change in credit risk compared to the base period can no longer be considered significant.

With the help of the above, companies' distribution according to stages can be calculated retroactively for each year, as shown in *Figure 2*.

[4] The base period is the year of inclusion in the portfolio, unless the transaction became part of the portfolio prior to the beginning of the sample period (2007), because in this case the base is 2007.

Figure 2
Distribution of companies across stages estimated to the sample period (based on number of cases)



Note: For the stage3 category, the estimate was prepared with the assumption of a 5-year average cleaning period (exiting the portfolio).

3. Model selection procedure

The so-called LASSO (least absolute shrinkage and selection operator) procedure was chosen for the selection of the explanatory variables. The procedure is related to the name of *Tibshirani* (*1996*) and is now applied in a number of places to support variable selection. Some years ago, the generalised version of the procedure (LARS) was applied by *Kok et al.* (*2017*) as well, expressly for the ECB's macro stress tests, to estimate the fee and commission component. Compared to other traditional model selection methods, the advantage of the solution proposed by Tibshirani is that during the optimisation process it not only lowers the coefficient of certain variables, but even reduces them to zero if necessary, which helps to avoid the overfitting stemming from the number of variables fed into the model. In addition, limiting the number of variables results in a model that is easier to comprehend and interpret.

Similarly to the ridge regression, the LASSO applies a so-called *lambda* tuning parameter for the shrinkage of the coefficients obtained through traditional estimation procedures (e.g. *least squares – LS, maximum likelihood – ML*). At the same time, as opposed to the ridge method, through the *lambda* it penalizes the absolute sum of the coefficients, and not their sum of squares. This important feature allows the method to be used efficiently for the selection of model variables as well. According to *Tibshirani* (*1996*), the correlation applied can be determined by the following equation for linear and logistic models:

LS: $$\beta^{LASSO} = \sum_{i=1}^{N}(y_i - \sum_j \beta_j x_{ij})^2 + \lambda \sum_j |\beta_j|$$

ML: $$\beta^{LASSO} = -ln\, L(\beta) + \lambda \sum_j |\beta_j|$$

Simplifying the above formula, the *beta* coefficients of the LASSO result from the sum of squares of the residuals and a penalization term, which latter is the value of the absolute sum of the *betas* multiplied by *lambda*. As in the LASSO method the transformations of the residuals and of the *betas* included in the element called penalization term are different (one of them is quadratic, while the other is an absolute value function transformation), by increasing the *lambda*, the shape of the originally quadratic function changes, and thus the optimum of the parameter not only approaches, but may even reach zero. The operating principle is also analogous in the case of the ML estimation procedure applied in the logistic model.

According to the theory, the optimum combination of the variables may be found where the *lambda* assumes a minimum value. Nevertheless, in practice it is recommended to include a buffer. Therefore, in line with *Hastie et al.* (*2009*), compared to the minimum value we set the value of the *lambda* parameter one standard deviation greater than the theoretical optimum. In accordance with this criterion, in terms of the probability of default and the various stage transition probabilities, the algorithm choses the combination of explanatory variables shown in *Table 1* as the one that has the best explanatory power.

Table 1
Explanatory variables selected on the basis of the selection procedure

Variable group	Variable name*	Given year (l0)	Previous period (l1)	Model
Macro variables	Employment (demp)	✓	✓	all
	Unemployment rate (dunrate)	✓	-	S12, S13
	Average earnings in the private sector (dlnpay)	✓	-	D
	Inflation (dcpi)	✓	✓	D, S12, S13
	Household income (dlnhhinc)	✓	✓	all
	Exchange rate (deurhuf)	✓	-	D, S13, S12
	Imports (dlnim)	-	✓	D
	Exports (dlnex)	-	-	-
	Interest rate (dbubor)	-	-	-
Financial variables	Return on assets (roa)	-	✓	all
	Capital adequacy (eq)	-	✓	all
	Debt coverage (dc)	-	✓	all
	Profit on sales (pos)	-	✓	D
	Short-term liquidity (shortli)	-	✓	all
	Long-term liquidity (longli)	-	✓	all
Non-financial variables	Segment	-	✓	all
	State/non-state	-	✓	all
	Domestic/Foreign	-	✓	all
	Sector	-	✓	all

*Note: * The working name of the variable is in brackets. The antecedents refer to the transformation of the variable. d means the first difference, while dln means the log-difference.*

4. Model results

4.1. PD model

The parameter estimation was performed with logistic regression (logit), the objective of which is to determine the probability of occurrence of the dependent variable. The logit transformation ensures unequivocal mathematical compliance between the [0;1] and [−∞; +∞] ranges, i.e. it ensures that the probabilities estimated for the dependent variable remain within the real domain. Accordingly, the probability of default (p) can be deduced as shown below:

$$p = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k)}},$$

where p is the probability of default, β_0 is constant, β_1 is a coefficient, and x_i is the explanatory variable.

The logistic regression model and its coefficients are presented in detail in *Table 9* in the *Annex*. As the logit coefficients cannot be interpreted in themselves, but only together with the constant and the other explanatory variables, this section shows us the impact of the individual variables through the so-called *average partial (marginal) effects*. The average partial effects appear in the form of probability values, the interpretation of which is simple, similarly to a linear probability model (LPM). The average partial effect shows to what extent on average the probability of default changes as a result of a unit of change in the given explanatory variable.

Table 2
Average partial probability coefficients of the significant macroeconomic variables of the logit model

Dependent variable: 'Default'	
Households' disposable income (dlnhhinc)	–0.1108*** (0.0229)
Inflation (dcpi)	–0.0008* (0.0004)
Employment lagged by one year (l1_demp)	–0.00005*** (0.0000)
Households' income lagged by one year (l1_dlnhhinc)	–0.1007*** (0.0259)
Imports lagged by one year (l1_dlnim)	0.0211*** (0.0001)

*Note: *p<0.1; **p<0.05; ***p<0.01, robust standard errors in brackets.*

The average partial coefficients of the explanatory variables of the model are intuitive in terms of both sign and relevance (*Table 2*). It was mainly the labour market situation and the indicators representing the financial position of the household sector that proved to have adequate explanatory power in terms of probability of corporate bankruptcy. The results show that a 1 per cent decline in household income (dlnhhinc) raises the probability of default by 11 basis points in the year of the shock, and – as a carry-over effect – nearly to the same degree in the following year as well. The labour market exerts its impact on the default rate through the change taking place in private sector employment (100,000 job losers raise the probability of bankruptcy by 50 basis points within a year). In addition to all of these factors, the role of the inflation environment is another determinant. According to the findings, the rise in inflation (dcpi) may be able to reduce the probability of bankruptcy in the corporate sector, which is presumably related to the gradual inflation of corporate loans outstanding.

Table 3
Average partial probability coefficients of the client-specific variables of the logit model

Dependent variable: 'Default'	
Return on assets (l1_roa_woe)	–0.00010*** (0.00000)
Capital adequacy (l1_eq_woe)	–0.00007*** (0.00000)
Debt coverage (l1_dc_woe)	–0.00005*** (0.00000)
Profit on sales (l1_pos_woe)	0.000001 (0.91243)
Short-term liquidity (l1_shortli_woe)	–0.00011*** (0.00000)
Long-term liquidity (l1_longli_woe)	–0.00010*** (0.00000)
Owner (= other than the state)	0.00864*** (0.00001)
Owner (= non-resident)	–0.00801*** (0.00000)
Segment (= micro/small)	0.00567*** (0.00000)
Sector (= medium risk)	0.00388*** (0.00024)
Sector (= high risk)	0.00780*** (0.00000)

*Note: *p<0.1; **p<0.05; ***p<0.01, robust standard errors in brackets*

Due to the multiple transformation, the interpretation of the WOE coefficients is cumbersome even with the average partial effects, but it can be established that the majority of the indicators under review are strongly significant, with the exception of the after-tax profit on sales (*Table 3*). One unit of change in the WOE value in the financial indicators exerts an impact between 0.5 and 1 basis point on average on the probability of default. Taking into account that the WOE values of the individual financial indicators are typically within the range of -100 and +100, it can be established that a major deterioration in an indicator that characterises the financial state of the firm (e.g. moving from the best category into the worst one) may increase the probability of default by as much as 100–200 basis points.

All of the applied non-financial indicators were found to be strongly significant. The contribution of individual factors to non-performance is significant, but in itself the effect of none of these exceeds 100 basis points. In terms of company size, the results correspond to previous studies, as the probability of default of the companies belonging to the larger-size group (medium/large) is 57 basis points lower on average than that of the smaller ones. The same is true for firms with majority state or local government ownership, where a probability of default lower by 86 basis points is measured. In line with previous views, foreign-owned companies are less risky than their Hungarian peers (80 basis points), while it was confirmed that in addition to financial indicators the nature of the activity also has explanatory power as there is a difference of 78 basis points between the best and the worst sectoral categories in terms of the probability of default.

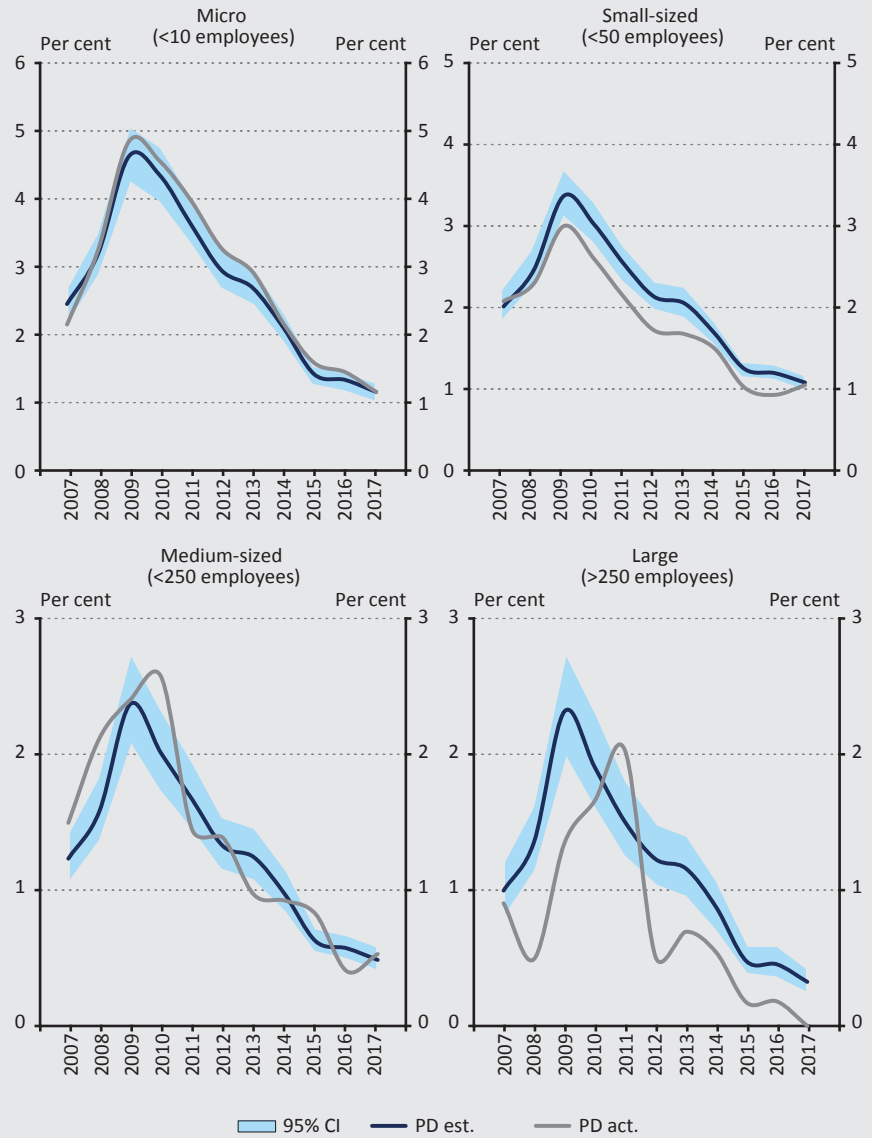
In addition to the above, we tested the impact of bank-specific features on the fitting of the model using dummy variables. Of the eight institutions, the coefficients of only two banks proved to be significant, indicating that in the model the differences appearing in banks' default rates can essentially be well captured with the help of the financial and non-financial variables included in the model. Of the aforementioned two banks, the coefficient of one of them became positive, while that of the other one became slightly negative, which is in line with the difference of the two banks' default rate time series from the average.

4.1.1. Backtesting

Based on the estimated probabilities of occurrence, the performance of the model can be backtested on the existing corporate sample in the individual company size categories. For the sake of simplicity, during backtesting the size categories were formulated taking into account the headcount.

The results shown in *Figure 3* reveal that the predictive power of the model declines with the increase in size. The underlying reason is presumably related to the decline in the number of sample elements. There are few (5,986) observations in the large corporations category, and thus idiosyncratic factors play a greater role. Nevertheless, the model is able to capture the unfavourable impact of a macroeconomic shock in each segment.

Figure 3
Estimated and actual default rates for different types of corporation



Note: The blue line shows the estimated values, the blue band the 95 per cent confidence interval, while the grey, continuous line depicts the actual values.

4.1.2. Validation

The accuracy of the parameter estimation can be measured with the help of cross validation as well. For this, it is necessary to divide the observations to k number of random samples. Following that, of the individual subsamples, group

k–1 constitutes the training set and one subsample constitutes the test set. The accuracy of estimation can be calculated from the repeated division of the various samples and test sets. In this study, 10 random samples were created, after which the results of the individual samples coincided with 97 per cent accuracy.

In addition to the above, two popular indicators can be applied for the goodness of fit and discriminatory power of the logistic regression model, which may be derived from the confusion matrices belonging to the various cutpoints. *Figure 4* shows that the ROC (receiver operating characteristic) curve of the logit model is above the 45-degree line. The value of the area under the curve (AUC) is 0.78, while the GINI shows a value of 0.56, which is considered a good value among similar models.

Figure 4
Area under the ROC curve of the PD model

4.2. Stage models

Unlike the PD model, the transition probabilities between stages are based on multinomial logistic regression, and not on a binomial one, which ensures the consistency of transition probabilities with one another, i.e. the sum of individual probabilities belonging to the possible outcomes is 1. In the three stage theories defined by IFRS 9, it can appear in a maximum of nine migration combinations,[5] i.e. three possible outcomes belong to a given stage. As during the stress test procedure, in line with the *EBA* (*2019*) methodology, recovery in a conservative

[5] (1) 1–3, (2) 2–3, (3) 1–2, (4) 3–2, (5) 2–1, (6) 3–1, (7) 1–1, (8) 2–2, (9) 3–3

manner is not allowed, and no separate estimations are prepared for the $stage_{3-1,}$ $stage_{3-2}$ and $stage_{3-3}$ categories in this study. Accordingly, two multinomial models in total were prepared for the estimation of the flows starting from stage1 and stage2.

During the separation of the stages, it was an important aspect to leave a sufficient number of observations in each group. Failing to do so raises the necessity of merging some stages. However, following the separation, sufficient numbers of observations remained in each category. In this respect, $stage_{2-X}$, i.e. the clients that migrate from stage2 in any direction can be considered the most critical factor, but the number of sample elements from this category to any of the possible directions was not less than 20,000, and the number of defaulting clients was not lower than one thousand.

In general, it can be stated of the stage models that in their case somewhat fewer explanatory variables proved to be significant than in the case of the PD model, which is in close correlation with the lower number of elements of the subsamples produced as a result of the creation of the stages. This is because the model selection procedure applied strives to avoid overfitting and thus optimises the number of incorporable explanatory variables to the number of observations. At the same time, it does not result in a distortion in terms of the final results.

Table 4
Logit coefficients of macroeconomic variables of multinomial stage models compared to the reference category

Dependent variable:				
	Stage(1–2)	Stage(1–3)	Stage(2–1)	Stage(2–3)
Employment (demp)			0.01*** (0.0004)	0.001 (0.001)
Unemployment rate (dunrate)	0.23*** (0.02)	0.13*** (0.02)		
Households' disposable income (dlnhhinc)	–10.99*** (0.62)	–4.42*** (0.09)	–0.37 (0.76)	–1.64*** (0.06)
Exchange rate (deurhuf)	0.01*** (0.001)	0.01*** (0.002)		
Inflation (dcpi)	–0.30*** (0.01)	–0.06*** (0.01)		
Employment lagged by one year (l1_demp)	–0.01*** (0.0003)	–0.004*** (0.0004)	0.002*** (0.0003)	–0.002*** (0.001)
Households' disposable income lagged by one year (l1_dlnhhinc)	4.48*** (0.40)	–1.98*** (0.05)		
Exchange rate lagged by one year (l1_deurhuf)	0.0001 (0.001)	–0.002 (0.002)		

*Note: *p<0.1; **p<0.05; ***p<0.01; standard errors in brackets. In each case, the chosen reference category corresponds to the starting stage, i.e. $stage_{1-1}$ and $stage_{2-2}$.*

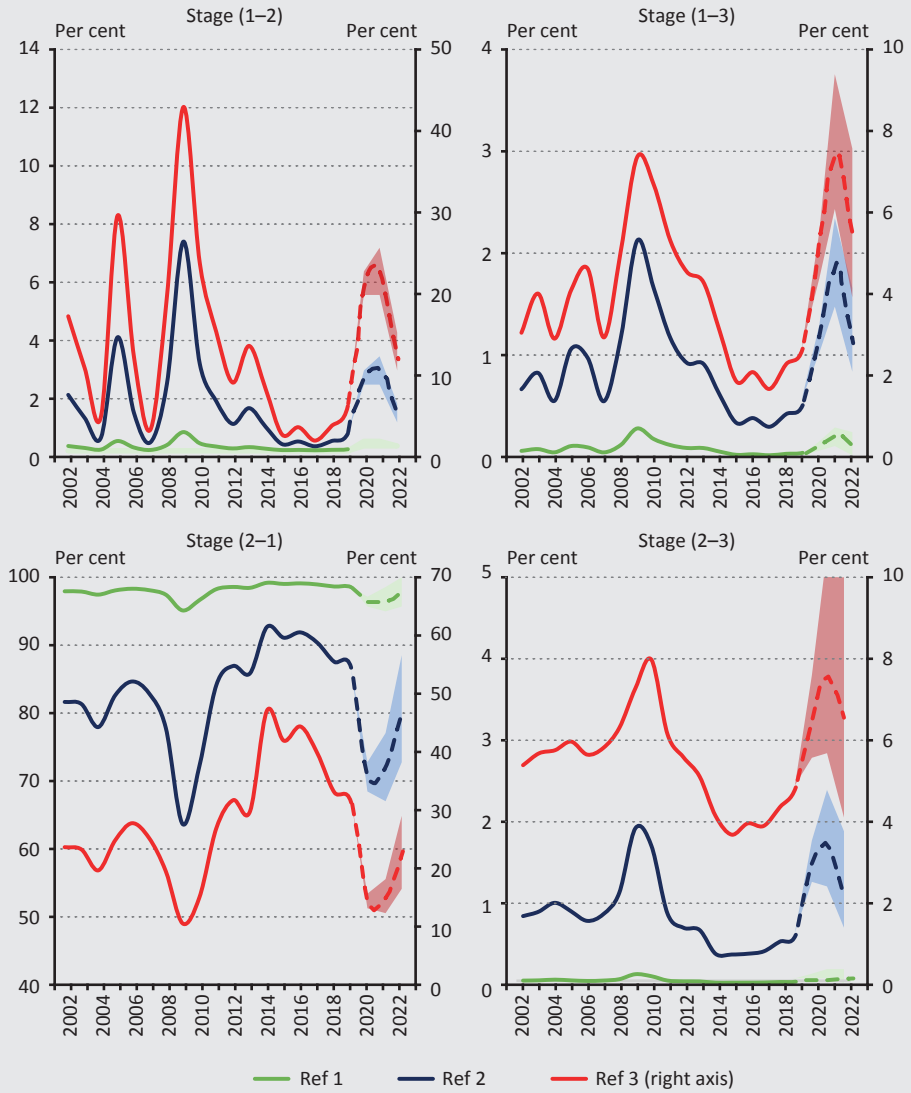
Regarding the explanatory variables, *Table 4* shows that out of the macro variables the roles of household income and labour market indicators dominate in almost all of the categories. Similarly to the default model, most company-specific variables are also significant: the indicators showing financial state are of great importance in the case of the stage models as well, although out of the non-financial variables the effect of company size could only be verified with an adequate confidence interval in the case of the $stage_{1-x}$ model. The coefficients of stage-models can be found in *Table 9* in the *Annex*.

5. Stress scenario

This section presents the estimation results regarding the probabilities of default and migration probabilities between stages in a presumed macroeconomic stress scenario. The estimation was prepared for three imaginary reference companies (Ref1, Ref2, Ref3) for the illustration. The first company (Ref1) belongs to the medium-sized/large corporation category, with a good financial background, i.e. its financial indicators correspond to the 75th percentile of the distribution, meaning an above-50 average WOE value within the typical range between [–100;+100]. In addition, it has foreign private ownership background and operates in a low-risk sector of the national economy. The second one (Ref2) is a domestic, privately-owned small company, with financial indicators just corresponding to the median, but with an activity in a medium-risk sector. In its other main features the third firm (Ref3) is identical to the previous one, but its financial position is worse, i.e. all of its financial indicators are below the average, showing a negative WOE value in the 25th percentile.

The stress scenario used in the example is a simulation that is based on a possible assumption that is significantly simplified compared to reality and that focuses only on some macroeconomic variables of key importance, and is not identical with the stress scenarios applied by the MNB. The imaginary scenario explores the impact of the macro environment on credit risk through the stressing of three main economic indicators. Households' disposable income falls by 5 per cent and 2.5 per cent in the first two stress years, and then remains stagnant. Employment declines by 100,000 and 50,000 people in the first and second years, respectively, in parallel with a respective 2 per cent and 1 per cent rise in the unemployment rate. The other parameters in this simplified model framework are unchanged.

Figure 5
Migration probabilities estimated to previous periods and forecasted by stage models with a given macroeconomic scenario*



Note: The bands indicate the 95 per cent confidence interval.

** The scenario presented is only for illustration, and does not correspond to the alternative scenarios applied by the MNB which are based on a consistent modelling and forecasting of macroeconomic variables.*

Figure 5 shows that in the presumed stress scenario the model is able to capture the impact of shock events on individual companies well. As a result of the stress applied, the probability of default of stage1 and stage2 clients increases significantly, while the probability of flowing into the worse category from the

former also increases, and the chance of flowing back weakens, which is in line with the preliminary assumptions.

6. Conclusion

This study aims to improve credit risk loss estimation, which is one of the most important components of the stress test framework, by making the estimation of corporate default and transition probability more accurate. On the basis of the results, it can be established that with the help of a wide-ranging set of variables containing macroeconomic and corporate information, and using an adequate selection algorithm (LASSO), we may be able to efficiently distinguish the actors of the corporate sector from one another in terms of riskiness, and thus to prepare a reliable estimate for the probability of default in a stress situation. By applying a close-to-reality but uniform stage2 set of rules and decomposing the database into subsamples, using a logic that is identical to the PD it is possible to prepare for the transition probabilities as well for a direct estimate that ensures similarly good fit, which may provide support for the quantification of credit risk loss arising in a stress situation. Based on the results of the models it can be established that in terms of the factors that capture the cyclical nature of corporate default and transition probabilities, the variables that characterise the state of the labour market and the income position of the household sector are considered the most determining and significant.

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Annex

Table 5
Descriptive statistics of the main explanatory variables

dlngdp	value	demp	value	dunrate	value	dlnpay	value
Minimum	–0.069	Minimum	–121.430	Minimum	–2.457	Minimum	0.032
1st quartile	0.003	1st quartile	–35.500	1st quartile	–0.962	1st quartile	0.039
Median	0.018	Median	35.320	Median	–0.142	Median	0.052
Average	0.010	Average	27.240	Average	–0.280	Average	0.056
3rd quartile	0.037	3rd quartile	77.370	3rd quartile	0.411	3rd quartile	0.070
Maximum	0.044	Maximum	136.250	Maximum	2.212	Maximum	0.110
dcpi	**value**	**dlnim**	**value**	**dlnex**	**value**	**dlnhhinc**	**value**
Minimum	–3.898	Minimum	–0.157	Minimum	–0.113	Minimum	–0.041
1st quartile	–1.940	1st quartile	0.033	1st quartile	0.037	1st quartile	–0.023
Median	0.144	Median	0.058	Median	0.065	Median	0.006
Average	–0.303	Average	0.036	Average	0.046	Average	0.008
3rd quartile	0.676	3rd quartile	0.094	3rd quartile	0.088	3rd quartile	0.039
Maximum	4.010	Maximum	0.131	Maximum	0.149	Maximum	0.061
dbubor	**value**	**deurhuf**	**value**	**dc_woe**	**value**	**roa_woe**	**value**
Minimum	–3.143	Minimum	–12.829	Minimum	–12.829	Minimum	–12.829
1st quartile	–1.906	1st quartile	0.155	1st quartile	0.155	1st quartile	0.155
Median	–0.619	Median	1.574	Median	1.574	Median	1.574
Average	–0.682	Average	4.908	Average	4.908	Average	4.908
3rd quartile	0.685	3rd quartile	10.066	3rd quartile	10.066	3rd quartile	10.066
Maximum	1.135	Maximum	29.102	Maximum	29.102	Maximum	29.102
eq_woe	**value**	**pos_woe**	**value**	**shortli_woe**	**value**	**longli_woe**	**value**
Minimum	–107.890	Minimum	–119.280	Minimum	–83.430	Minimum	–65.987
1st quartile	–31.930	1st quartile	–12.110	1st quartile	–34.310	1st quartile	–17.100
Median	31.540	Median	33.640	Median	23.000	Median	24.651
Average	24.470	Average	20.450	Average	16.700	Average	6.621
3rd quartile	79.050	3rd quartile	68.490	3rd quartile	69.610	3rd quartile	24.651
Maximum	131.20	Maximum	89.910	Maximum	96.050	Maximum	46.376

Source: MNB

Table 6
Unit of measurement and transformation of macroeconomic variables

Long name	Short name	Units of measurement	Functional form applied
Gross domestic product (GDP)	gdp	HUF million, at year 2015 prices	log-difference (dlngdp)
Private sector employment	emp	thousands persons	first difference (demp)
Unemployment rate	unrate	per cent	first difference (dunrate)
Gross average wages in the private sector	pay	HUF/month	log-difference (dlnpay)
Inflation	cpi	year-on-year, %	first difference (dcpi)
Imports	im	HUF million, at year 2015 prices	log-difference (dlnim)
Exports	ex	HUF million, at year 2015 prices	log-difference (dlnex)
Household's disposable income	hhinc	HUF million, at year 2015 prices	log-difference (dlnhhinc)
EUR/HUF exchange rate	eurhuf	HUF	first difference (deurhuf)
3-month BUBOR rate	bubor	per cent	first difference (dbubor)

Source: MNB

Table 7
Client-level financial and non-financial variables

Name	Short name	Variable form*	Formula
Return on assets	roa	continuous	*After-tax income/Assets*
Capital adequacy	eq	continuous	*Equity/Liabilities*
Debt coverage	dc	continuous	*EBITDA/Liabilities*
Short-term liquidity	shortli	continuous	(*Cash and equivalents + Securities*)/*Short term liabilities*
Long term liquidity	longli	continuous	*Long-term liabilities/Non-current assets*
Profit on sales	pos	continuous	*After-tax income/Sales revenue*
Export ratio	exp	continuous	*Export sales revenue /Sales revenue*
State owner	-	categorical	$(Registered\ capital_{state} + Registered\ capital_{local\ governments})/Registered\ capital_{total} > 0.5$
Foreign owner	-	categorical	$Registered\ capital_{foreign}/Registered\ capital_{total} > 0.5$
Segment	-	categorical	Act XXXIV of 2004 (SME Act)
Sector		Categorical	Based on rating (see *Table 7* in the *Annex*)

Source: MNB company database

Figure 6
WOE values belonging to the variable categories

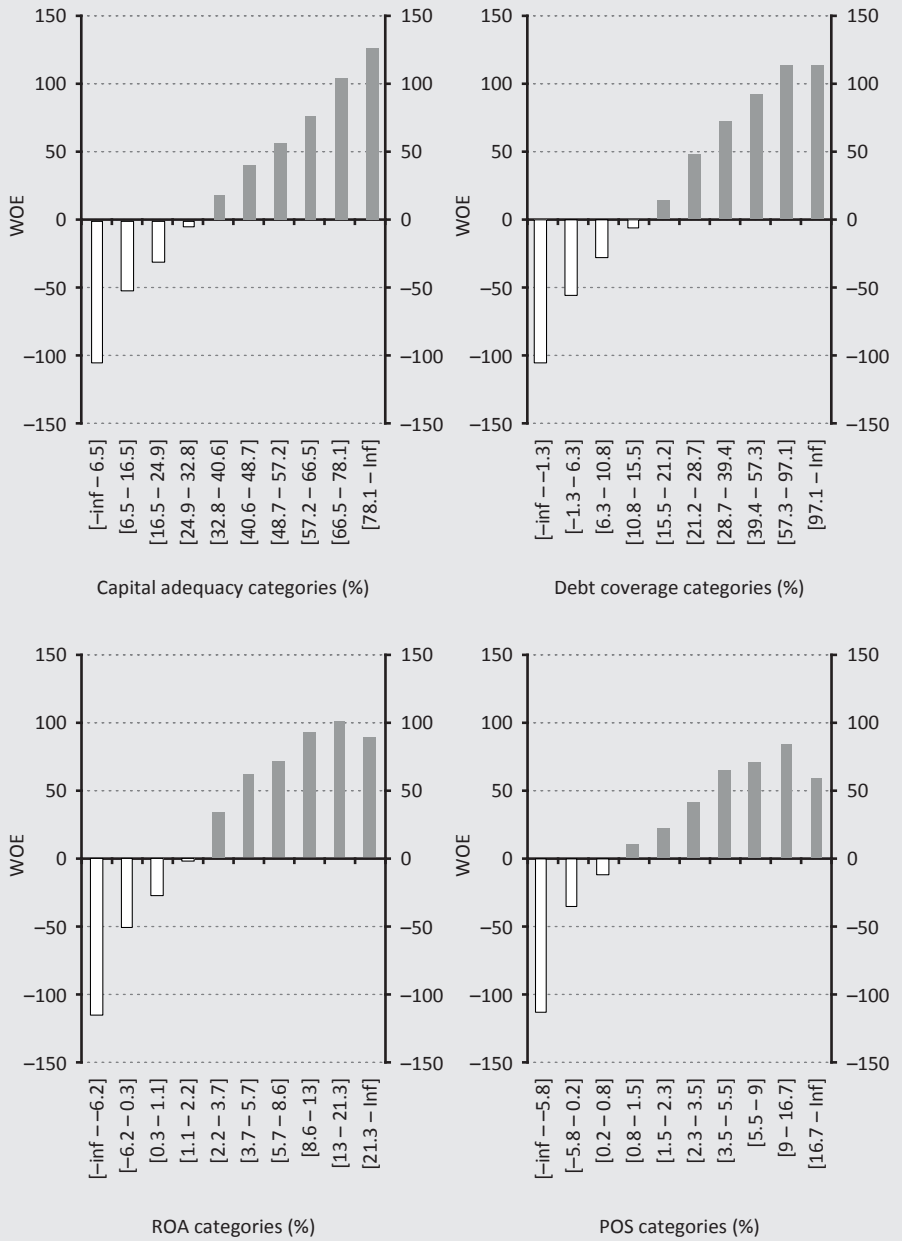

Figure 6 (continued)
WOE values belonging to the variable categories

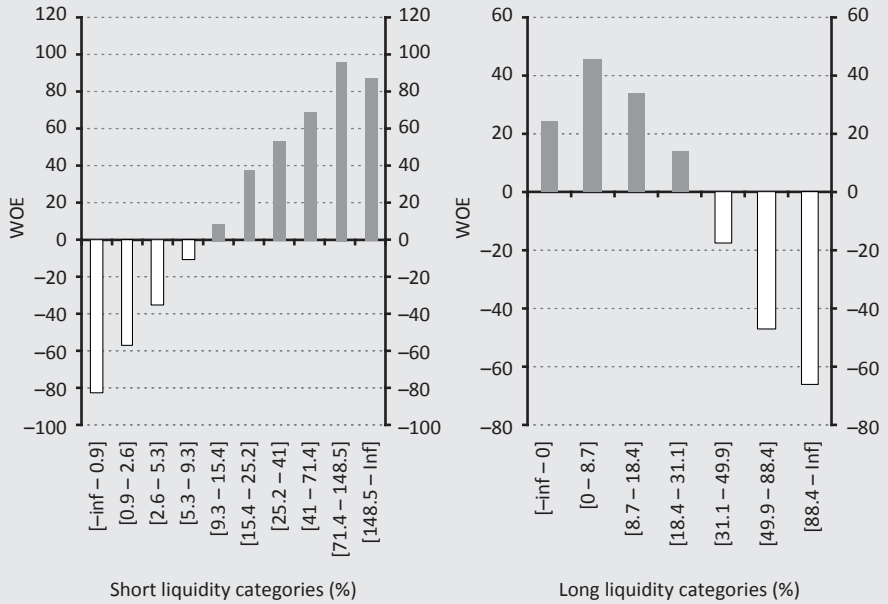

Table 8
Classification of sectors into rating categories

NACE sectors	Default rate (per cent)	Defaulted number of observations (pcs)	Total number of observations (pcs)	Rating-category
Real estate activities	4.7%	582	12,267	3
Transportation and storage	4.4%	1,335	30,184	3
Financial and insurance activities	4.4%	109	2,483	3
Construction industry	4.0%	1,046	26,321	3
Accommodation services	3.8%	257	6,717	3
Information and communication	3.8%	436	11,507	2
Trade and repair of vehicles	3.6%	2,851	79,123	2
Professional, scientific and administrative	3.3%	1,264	37,907	2
Manufacture	3.1%	1,441	46,866	2
Unknown sector	2.8%	22	779	2
Other activities	2.4%	253	10,740	1
Water supply, sewage, waste management	2.3%	67	2,886	1
Mining, mining services	2.1%	12	584	1
Agriculture, forestry, fishing	1.7%	293	16,840	1
Electricity, gas and steam supply	1.5%	18	1,241	1

Source: MNB default database

Table 9
PD and stage models

	Dependent variable:				
	Default binomial logit	Stage(1–2) multinomial logit	Stage(1–3) multinomial logit	Stage(2–1) multinomial logit	Stage(2–3) multinomial logit
Macroeconomic variables					
Employment (demp)	–0.0002 (0.0004)			0.01*** (0.0004)	0.001 (0.001)
Unemployment rate (dunrate)		0.23*** (0.02)	0.13*** (0.02)		
Household's disposable income (dlnhhinc)	–5.58*** (1.15)	–10.99*** (0.62)	–4.42*** (0.09)	–0.37 (0.76)	–1.64*** (0.06)
Exchange rate (deurhuf)	0.003 (0.004)	0.01*** (0.001)	0.01*** (0.002)		
Average earnings in the private sector (dlnpay)	–0.90 (1.80)				
Inflation (dcpi)	–0.04* (0.02)	–0.30*** (0.01)	–0.06*** (0.01)		
Employment lagged by one year (l1_demp)	–0.003*** (0.0005)	–0.01*** (0.0003)	–0.004*** (0.0004)	0.002*** (0.0003)	–0.002*** (0.001)
Households' disposable income lagged by one year (l1_dlnhhinc)	–5.39*** (1.30)	4.48*** (0.40)	–1.98*** (0.05)		
Inflation lagged by one year (l1_dcpi)	–0.02 (0.02)				
Imports lagged by one year (l1_dlnim)	1.06*** (0.27)				
Exchange rate lagged by one year (l1_deurhuf)		0.0001 (0.001)	–0.002 (0.002)		
Client-level financial variables					
Return on assets (l1roa_woe)	–0.005*** (0.0005)	–0.01*** (0.0002)	–0.01*** (0.0003)	0.01*** (0.0003)	–0.0003 (0.001)
Capital adequacy (l1eq_woe)	–0.003*** (0.0002)	0.002*** (0.0002)	–0.003*** (0.0003)	0.002*** (0.0003)	–0.003*** (0.001)
Profit on sales (l1pos_woe)	–0.0001 (0.0005)				
Debt coverage (l1dc_woe)	–0.003*** (0.0003)	–0.01*** (0.0002)	–0.003*** (0.0004)	0.004*** (0.0004)	–0.0003 (0.001)
Short liquidity (l1shortli_woe)	–0.01*** (0.0003)	–0.01*** (0.0002)	–0.01*** (0.0003)	0.01*** (0.0003)	–0.002*** (0.001)
Long liquidity (l1longli_woe)	–0.005*** (0.0004)	–0.01*** (0.0003)	–0.01*** (0.0004)	0.01*** (0.0005)	–0.003*** (0.001)
Client-level non-financial variables					
Owner (= other than the state)	0.55*** (0.16)	1.23*** (0.11)	0.94*** (0.19)	–1.27*** (0.18)	–0.61* (0.33)
Owner (= non-resident)	–0.48*** (0.06)	–0.74*** (0.04)	–0.60*** (0.07)	0.60*** (0.07)	–0.45*** (0.16)
Segment (=micro/small)	0.32*** (0.05)	0.10*** (0.03)	0.39*** (0.06)	–0.09* (0.05)	0.09 (0.12)
Sector (= medium risk)	0.20*** (0.05)	0.29*** (0.04)	0.20*** (0.06)	–0.25*** (0.06)	0.32** (0.14)
Sector (= high risk)	0.37*** (0.06)	0.62*** (0.04)	0.46*** (0.06)	–0.53*** (0.07)	0.33** (0.15)
Constant	–4.93*** (0.19)	–4.79*** (0.11)	–5.29*** (0.19)	1.73*** (0.19)	–2.49*** (0.35)
Number of observations	254,590	230,413	230,413	23,094	23,094

*Notes: *p<0.1, **p<0.05, ***p<0.01; standard errors in brackets and l1: the value lagged by one year*

Decentralized Finance – The Possibilities of a Blockchain "Money Lego" System*

Tamás Katona

With the adoption of blockchain technology, initiatives to provide financial, investment and insurance services to a wide range of users in a decentralized manner have emerged. But can decentralized finance be the alternative to the traditional financial system, or has it only created another "technology playground" for users who are biasedly enthusiastic about crypto-assets? The study examines the key definitions of decentralized finance and then synthesizes them to formulate a new, more complete definition. This is followed by a presentation of the different layers of decentralized finance and their prevalence, as well as an analysis of its benefits and risks. In the conclusions, the author finds that decentralized finance has the potential to provide financial services with an open, transparent and robust infrastructure, and has the possibility of reaching a broad range of users with its basic financial services. However, this requires further development of the sector and effective management of emerging risks.

Journal of Economic Literature (JEL) codes: G10, G15, G20, G23, G24, G28

Keywords: blockchain, decentralized finance, Ethereum, crypto-assets, smart contract, yield farming, liquidity mining

1. Introduction

The financial system has undergone fundamental changes in recent years, with the appearance of the FinTech sector.[1] New providers have entered the financial markets, combining digital technologies and financial services in a more efficient and innovative way than any other solution so far. The FinTech ecosystem consists of vastly diverse players, some of which provide new products and services, occasionally outside existing regulations, while others seek to sell products offered

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[1] The FSB defines FinTech as "*technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services*" (*FSB 2017:7*).

by existing, legacy financial institutions in an innovative form and way. Within the sector, the use of distributed ledger technology and within that the blockchain technology creates the opportunity to reshape the money, capital and insurance markets, by way of disintermediation. As a result of decentralization, new – as yet untested – business models which affect all elements of financial value chains have emerged. Since the network is capable of recording past transactions securely and immutably, blockchains can easily be optimised for a broad range of activities and objectives. For this reason, the blockchain technology could be a "disruptive innovation" (*Dell'Erba 2019*). The application of blockchain technology could "*lead to a reduction of industry rents for the benefit of end investors and of the end users of finance (entrepreneurs and businesses) enhancing market welfare"* (*Avgouleas – Kiayias 2018:1*).

The research group of one of the most important trading platforms, Binance, is of the opinion that the emergence of crypto-assets,[2] including the incorporation of assets existing in the real economy in the form of tokens on the blockchain, i.e. tokenization, has enabled the use of blockchain technology in all sectors, but especially in the service sector (*Binance Research 2019a*). The worldwide, open-source nature of the public, permissionless blockchain[3] allows anyone to join, as opposed to the closed character of centralized financial systems. In decentralization, information is distributed over computer networks without the need for a central actor. In theory, this can result in an unbiased, transparent, immutable and efficient system (*Maker Team 2020*). Another significant benefit of public blockchains is standardisation, as developers can implement individual business models at low cost and in an interoperable[4] manner in a distributed ledger technology system. Linked to this is programmability, which allows *inter alia* for automatic compliance with rules and regulations and other standards.

Approached from the side of transaction costs, *Cong and He* (*2019*) found that blockchain technology, due to decentralization and disintermediation, makes it possible to reduce transaction costs associated with finding and selecting a counterparty, concluding a contract and enforcing a claim. Thus, the parties contact one another directly and execute transactions in innovative ways *(peer to peer).*

[2] e.g. Bitcoin (BTC), Ether (ETH) etc.
[3] With such blockchains, anyone can participate in the blockchain consensus mechanism, and anyone with an Internet connection can perform transactions in the network and get to know the full transaction log (*EC JRC 2019*).
[4] Interoperability is the ability of different IT and network systems to exchange and make use of information.

It is important to emphasize that the provision of financial services today is strongly affected by platformization, due *inter alia* to open banking efforts as a result of PSD2 regulation and the expansion of BigTech companies. *Alstyne et al.* (*2016*) define platforms as business models "*creating value by facilitating interactions between external producers and consumers*". In financial markets, marketplace-type interfaces, where users can access various financial services and non-financial products and services in one place, are becoming increasingly prevalent. Decentralized finance (DeFi) seeks to combine platformization, open banking efforts and blockchain technology to create a global, efficient and decentralized marketplace where users with Internet connection can access an increasingly wide range of financial services (financial, investment and insurance services and payment transactions). The question arises as to whether all of this can be achieved using blockchain technology? Is it possible to operate a decentralized trading platform or to create derivative products? DeFi, which aims to be an alternative to the traditional financial system, seeks to achieve these goals. But is it really capable of accomplishing this ambitious goal, or it is only another "technology playground" created for users who are biasedly enthusiastic about crypto-assets? Furthermore, will the blockchain be able to catalyse the transformation of the entire financial value chains, or will it remain a solution that improves only one sub-process or a single element of the value chain? Among other things, this article seeks to answer this, all the more so, because several Hungarian market participants have been actively involved in the DeFi ecosystem in some form, and domestic users also use DeFi protocols.

2. Problem statements, research questions and the structure of analysis

The fundamental aim of the study is to create a new, comprehensive definition by examining the concept of DeFi, and to present how the ecosystem is structured. It reviews the most important definitions and by synthetizing these, it attempts to describe the concept with its own definition. The question also arises as to what is needed for the wider acceptance of DeFi and in what direction it needs to develop in order to become competitive with the traditional financial system? To this end, the study examines the different layers, prevalence, benefits and opportunities of DeFi, as well as the most significant risks inherent in the system. Finally, based on the findings of the research, the results are presented and conclusions are drawn.

3. Methodology and review of literature

The methodology developed for writing this study is mainly a descriptive, qualitative analysis, which was combined with an evaluation of indicators from public online databases. The use of language in the analysis focuses on comprehensibility in order for the professional and non-professional audience to get to better know and understand this rather new field of science. Since while the topic has become increasingly popular in the international literature,[5] there are quite a few printed publications and monographs in the Hungarian literature that meet the scientific criteria.[6] The Internet is the primary forum used by the DeFi community for publication. Apart from documents containing technical and fundamental analyses, which account for a significant proportion, online contents dealing with the sector, both scientific and non-scientific, can be divided into two well-defined groups. The majority of the sources are documentation describing and analysing the initiatives, such as white papers, frequently asked questions and answers to such. This is the basis for summaries and dissertations that analyse them from a critical point of view, as well as studies that make findings about the DeFi ecosystem or its elements. The vast majority of the sources were written in English, the reason for which is that DeFi builds on the traditionally English-language technology layers and IT infrastructures. Although the sources are of different scientific value, the study took into consideration the relevant publications with both scientific thoroughness and emphasis on more common language. This study attempts to describe DeFi with scientific rigour.

4. Definition and key features of DeFi

As indicated in the introduction, DeFi seeks to create a new ecosystem based on global, decentralized financial services that is easily accessible to everyone and does not require a central authority (*Sandner – Wachter 2019*). According to *Consensys* (*2020*), DeFi is actually a shift from traditional centralized financial systems to peer-to-peer financial solutions enabled by decentralized technologies primarily built on

[5] This is supported by the fact that on the arXiv.org site, operated by Cornell University, the number of studies containing the term DeFi and published between 2016 and 2021 was 417 on 18 January 2021.

[6] DeFi has been studied in a scientific manner, or in an understandable way, primarily in Internet contents. Examples include blog posts on one of the broker-dealer trading platforms, Coincash's blog dealing with DeFi in general (*CoinCash 2020a*), describing the most significant initiatives (*CoinCash 2020b*), or SushiSwap (*CoinCash 2020c*).

the Ethereum[7] blockchain. At the same time, DeFi protocols[8] have emerged and operate on other blockchains (e.g. EOS, TRON, or Cosmos) (*Binance Research 2020*).

Although there is no uniformly accepted definition of DeFi, the literature and market participants more or less mean the same thing by the concept. Related to this, *Birch* (*2020*) notes (somewhat ironically) that "*heads of DeFi companies seem unable to define the sector in a few sentences*". According to *John* (*2020:18*), DeFi *"is a term used to refer to a stack of applications run primarily on blockchains that are emerging as an alternative to the traditional banking ecosystem"*. The above definition implies that DeFi applications use so-called *stablecoins*[9] (e.g. USDT, USDC, Dai, etc.) and additional crypto-assets (e.g. ETH, Wrapped Bitcoin, 0x, etc.) for payment transactions, lending or trading instead of fiat currency. According to the definition of the *Binance Academy* (*2020a*), DeFi is an "*ecosystem comprised of financial applications that are being developed on top of blockchain systems*". It is noteworthy that, on the regulatory side, the Polish Financial Supervision Authority (UKNF), was among the first to define DeFi similarly to Binance's definition as "*an ecosystem of applications aimed at the provision of financial services on DLT*" (*UKNF 2020:6*).

Indeed, the essence of DeFi may also be captured by the fact that the role of the financial intermediary is taken over by the self-executing computer code, the smart contract. *Sandner and Wachter* (*2019*) describe DeFi with a similar definition*:* "*an ecosystem comprised of applications built on top of public distributed ledgers, for the facilitation of permissionless financial services".* Almost the same definition is formulated by *Schär* (*2020:1*), who argues that DeFi includes "*open financial infrastructures built upon public smart contract platforms, such as the Ethereum blockchain"*. *Zetzsche et al.* (*2020*) emphasize the decentralized nature of financial service provision. According to the authors, infrastructure, markets, technology, methods and applications that enable the decentralized provision of financial services are at the core of DeFi. *Birch* (*2020*) approaches the concept in terms of interoperability: *"DeFi is a financial ecosystem, in which it is possible to build tools,*

[7] Ethereum is an open source, public, blockchain-based distributed computing platform capable of creating, managing, and executing smart contracts. *Schär* (*2020:1–2*) emphasizes that smart contracts are "*small applications stored on a Blockchain and executed by a large network of many computers. (…) Their advantage is a high level of security, in the sense that smart contracts guarantee deterministic execution and allow anyone to verify the resulting state changes"*.

[8] For the purposes of this study, a protocol is a set of rules and procedures that operate a particular decentralized application or applications. A decentralized application (or app) is a software application that runs on a distributed network. The application is not provided by a central server, but by a decentralized network based on the protocol. Basically, the term protocol is used as the collective term for each DeFi provider (e.g. Uniswap).

[9] There is no clearly defined normative definition of the term. According to Global Digital Finance (GDF), an international market self-regulatory organization, "*a stablecoin is a cryptoasset that serves as a medium of exchange and a store of value and is structured to minimise price volatility*" (*GDF 2019a:2*, *2019b:2*). From a monetary point of view, European Central Bank experts have defined stablecoins as "*digital units of value that are not a form of any specific currency (or basket thereof) but rather, by relying on a set of stabilisation tools, try to minimise fluctuations in their price in such currencies"* (*Bullmann et al. 2019:2*).

services and smart contracts and then bond them together on a blockchain, just like lego". Summarizing the various definitions above, from a technical point of view, DeFi can be defined as *the (eco)system of public, permissionless, DLT-based, interoperable protocols and decentralized applications (so-called DApps) built upon them for the provision of financial services.*

In addition, for biased users, DeFi also represents a kind of belief and philosophy. According to *Birch* (*2020*), *"blockchain technology and cryptocurrency are philosophically driven".* In this regard, *Binance Academy* (*2020a*) defines DeFi as "*the movement that promotes the use of decentralized networks and open-source software to create multiple types of financial services and products*".

As already mentioned, in contrast to the traditional financial system, the DeFi ecosystem typically does not rely on centralized intermediaries and institutions but is based on public protocols and decentralized applications. "*... transactions are executed in a secure and deterministic way, and legitimate state changes persist on a public blockchain. Thus, this architecture can create an immutable and highly interoperable financial system with unprecedented transparency, equal access rights ..."* (*Schär 2020:1*). This also means that the use of intermediary institutions (custodians, central clearing houses, etc.) becomes less necessary (*Schär 2020*). An example of putting this principle into practice is that users only need a non-custodial wallet[10] (e.g. MetaMask, Gnosis, Argent) to access DeFi applications and execute transactions. By using such a wallet, the user does not lose control over the crypto-assets and can continuously monitor the status and other details of the transaction initiated. Furthermore, the users have the ability to learn all DeFi transactions (e.g. by using Etherscan).

Unlike traditional financial IT solutions, the source codes of DeFi applications are public, so they can be verified and audited by anyone. Moreover, if the source code is published, for example on the GitHub site, the user can even copy or alter it, thus creating a new protocol.

All of the above definitions state that DeFi is aimed at providing financial services. To acquire an accurate knowledge of the DeFi system, let us look at the financial services offered. Summarizing the findings of *Binance Academy* (*2020a*), *Sandner*

[10] In the case of such wallets, the user remains in possession of the private keys required to dispose over the crypto-assets. Losing the private keys or the phrases needed for the recovery also means losing the right to dispose over the crypto-assets. The security of the system is guaranteed by the fact that the public code cannot be inferred from the public address and the private code cannot be inferred from the public code (*ESMA 2019*).

– *Wachter* (*2019*)*, Schär* (*2020*) and *Maker Blog* (*2020b*), the financial services affected by DeFi can be currently classified into the following groups (also referred to in the literature as DeFi functions):

a) Services similar to monetary banking services (issuance of stablecoins and operation of related payment systems, e.g. MakerDao, EOSDT, Kava);

b) Operation of decentralized trading platforms (DEX), with possible liquidity pooling services associated with them (e.g. Uniswap, Curve Finance, Swerve, BurgerSwap, PancakeSwap);

c) Provision of peer-to-peer and liquidity pool type lending and borrowing platforms (e.g. Aave, Compound);

d) Provision of higher level, complex financial products, which includes the creation of derivatives, tokenization platforms (e.g. Synthetix, Balancer) and prediction markets (e.g. Augur);

e) Insurance products and services (e.g. Nexus Mutual, 3 F Mutual).

Initiatives in the DeFi sector typically aim to implement multiple functions or to provide a kind of "hybrid" service by combining one or more features thereof. This is because in this manner developers try to solve the difficulties and issues arising when using the individual features. On the other hand, they also want to encourage users to use the protocols. All of these help increase the value of the platform and result in new, innovative business models. For example, the Uniswap protocol previously had a basically decentralized trading platform function, but later the liquidity pool function known from Compound was incorporated. This made it possible to better ensure the appropriate level of liquidity required for trading, for instance for swaps, and has thus facilitated the more efficient operation of the protocol. This business model of Uniswap, the automated market maker[11] (*Shevchenko 2020b*), has become a standard in the sector. This is also supported by the fact that using the publicly available source code of Uniswap, the developers created different copies (*fork*) on each blockchain (e.g. SushiSwap, Burgerswap, WhiteSwap) (*Binance Academy 2020b*).

[11] Automated market marker: *"the AMM is a type of decentralized exchange (DEX) protocol that relies on a mathematical formula to price assets. Instead of using an order book like a traditional exchange, assets are priced according to a pricing algorithm."* (*Binance Academy 2020c*).

4.1. Layers of DeFi – the Money Lego concept

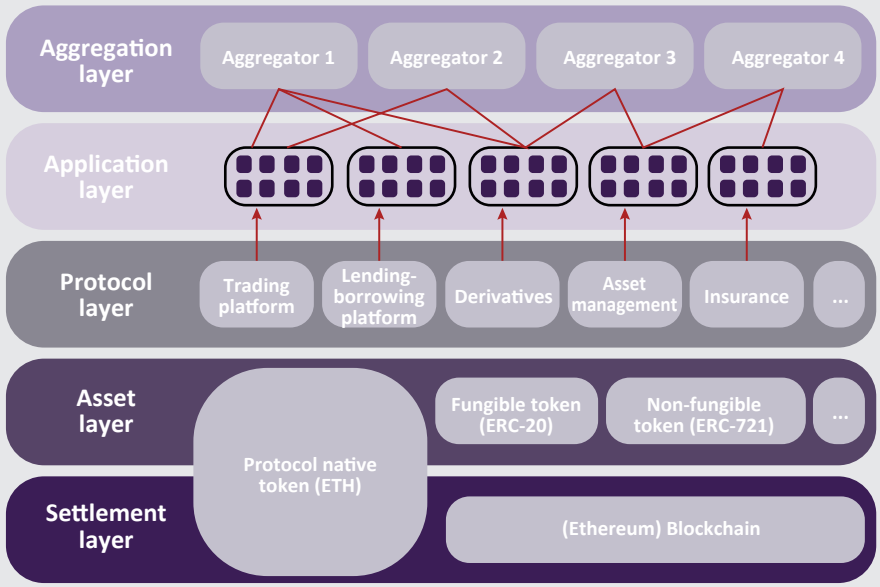
The DeFi ecosystem is often referred to as Money Lego. The concept itself suggests that in a decentralized financial system, the individual protocols and applications are able to interact with one another. Similarly to how Lego building blocks can be assembled, individual protocols and applications of DeFi can be combined to achieve the optimal transaction output (*John 2020; Amler et al. 2021*). This opens up the opportunity to create complex transactions, while also providing an outstanding user experience.

The interoperability and financial nature of DeFi is well illustrated by the so-called *Schär* (*2020*) model that shows how each DeFi application and protocols are built on one another as layers. The lowest layer (settlement layer) is the blockchain used, which contains the basic operating rules of the ecosystem. In fact, transactions are executed at this level. The second (asset) layer is built on this, which includes the created crypto-assets (e.g. ETH, Dai). The main functions of DeFi are set out in the third protocol layer.

The next layer is the application layer, which includes user-oriented applications that interconnect the protocols and standards in the individual protocol layers. The interconnection of smart contracts takes place in a web browser-based front-end interface; therefore, the protocols are easy to use and have a high user experience. The aggregation layer is built on (top) the application layer, which is actually an extension of it. Aggregators operate user-centric platforms that connect many different applications and protocols. The platforms involved provide users usually with tools to compare the services and the corresponding costs, and to make otherwise complex transactions easy. Aggregators achieve this by simultaneously interconnecting many different protocols and linking relevant information obtained from each platform. Applications running in this layer allow the user to make informed decision and optimize the benefits obtained by using DeFi applications (*Schär 2020*).

Figure 1 shows the Schär model related to Ethereum. It is clear that the layers involved are hierarchically built on one another in two respects. On one hand, it is important to emphasize that the implementation of each DeFi function is the result of the interactions and transactions of each layer with one another. On the other hand, it must be stressed that, the extent to which a layer is scalable, decentralized, or vulnerable is determined by the features of the underlying blockchain (particularly the applied consensus mechanism) (*Hay 2019; Amler et al. 2021*).

Figure 1
A Decentralized Finance Stack



Source: Plotted based on Schär (2020:3–4)

To illustrate the above, in the DeFi ecosystem, users have the option to take out a loan in Dai stablecoin against their existing ETH equivalent to the value of USD 100, with which they can carry out leveraged trading – let us say – in some other crypto-asset and can then swap the acquired assets on a decentralized trading platform back to Dai and repay the loan. They can arrange the order of transactions with an aggregator application (e.g. Furucombo) for an optimal output and the highest level of user experience. It is also important to note that DeFi applications are available on an ongoing basis, 24 hours a day, 7 days a week.

4.2. Decentralization and yield farming

The concept of decentralization permeates DeFi and represents one of its most important principles. Nevertheless, developers often have to compromise between the level of decentralization and the pragmatism that prioritizes creating a useful product. Therefore, the ideology behind DeFi is a complex blend of decentralization and pragmatism (*Shevchenko 2020a*). While in the case of the blockchains that form the lowest layer of DeFi, due to its distributed ledger technology character, the operation of the network is decentralized and the extent of decentralization may be different for each DeFi protocol. At present, it seems that each initiative

sets the centralization-decentralization ratio on a kind of sliding calliper. Once the initiative is ripe for a higher degree of decentralization, developers will begin to implement it. This was also pointed out by Gustav Arentoft, the European business development representative for the stablecoin initiative at MakerDao, who does not believe that "*[DeFi] is binary in the sense that you are either decentralized or you're like traditional finance. I believe that, on the spectrum, there's space for a lot of different uses"* (*Birch 2020*).

The current highest level of decentralization is perhaps the so-called decentralized autonomous organization, or DAO for short. According to the definition of *Binance Research* (*2019b*) DAO is an *"organizational form"* that exists in the virtual space *"that coordinates the efforts and resources of members via an a priori binding, formalized and transparent set of rules that are agreed upon in a multilateral fashion"*. This is often done in a way that the protocol creates and distributes among users crypto-assets, the so-called secondary or governance tokens embodying the membership rights in the DAO. By holding this, the user can make motions and has voting rights depending on the amount of token held, i.e., can actively influence the operation of the protocol. In addition to buying from the open market, secondary tokens can be obtained from the platform by the users of the protocol concerned, depending on the intensity of use, typically the amount of liquidity made available to the platform (*liquidity mining*). As the number of users changes due to network effects, the value of the platform and as well as the value of the secondary token also changes (*Dale 2020a*). The consequence of the distributed governance model is that users are interested in participating in its governance, as the value of the tokens they hold also depends on the success of the protocol.

At present, almost all decentralized initiatives use the services of other, possibly centralized, entities. The most important of these are oracles. Oracles are "*third-party services that allow smart contracts within blockchains to receive external data from outside of their ecosystem*" (*Tiwari 2020*). Oracles are data sources that can be channelled into smart contracts. This allows smart contracts to access real-time data that is not on blockchains (*Liu et al. 2020:2*). Most often, such data is the real-time price feed of crypto-assets. Oracles alone do not qualify as data sources; they represent a layer that verifies real-world events related to data on the blockchain and submits cumulative data to smart contracts (*Tiwari 2020*).

As a result of decentralization, specifically the secondary token distribution of the Compound liquidity platform, yield farming has emerged. Users using such a strategy lock their available crypto-assets in the liquidity pools promising the highest interest rates, and then they also lock the crypto-assets received as a reward or interest (or the crypto-assets replacing them or acquired against them) on other

platforms to achieve the greatest benefit. Users using a yield farming strategy lock their crypto-assets for a very short period of time (weeks, days, and even a few hours) and, if there is a possibility of arbitrage, they immediately transfer their sources to the new platform. It can be seen that liquidity mining facilitates the implementation of the yield farming strategy. After all, in exchange for providing liquidity, i.e., for locking assets, the user gets a new crypto-asset, a secondary token, the value of which changes with the value of the platform (*Dale 2020a*). At the same time, the user has the option to further lock the secondary tokens received.

5. Examination of key indicators of DeFi

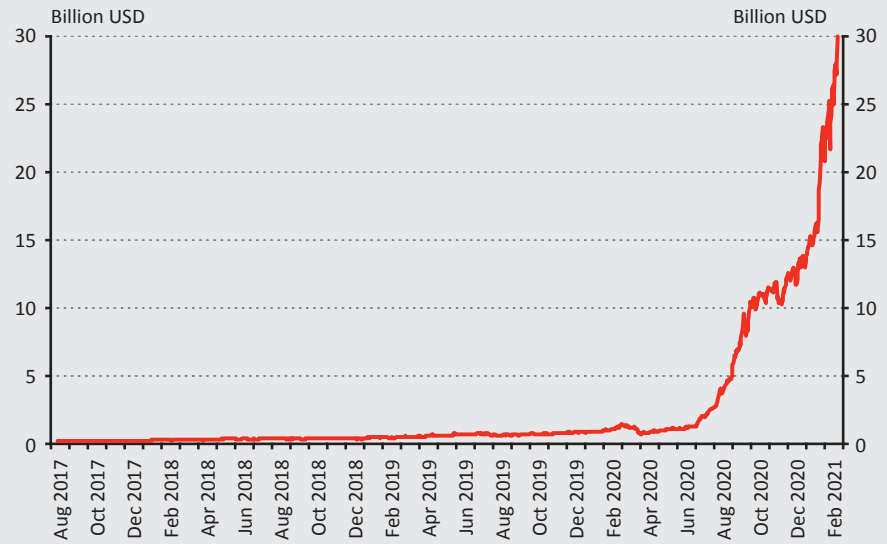
The size of the DeFi sector is illustrated by the aggregate capitalization of the 100 crypto-assets in the ecosystem with the most significant market capitalization. This gives an idea what market participants consider about the combined value of each protocols that belong to DeFi and create crypto-assets. According to the DeFi Market Cap,[12] a portal providing market data, the value of the indicator in question exceeds USD 37.7 billion. CoinGecko,[13] which provides the same service but is likely to use different data and methodologies, sets the amount of combined capitalization similarly at approximately USD 55.8 billion. This ratio is approximately 30 per cent of ETH's market capitalization. Nevertheless, the index surveyed is still a fraction of the S&P 500 index's capitalization of approximately USD 30 trillion.

In addition to capitalization, the most important indicator of the DeFi sector – mainly published on the defipulse page – has become the total value of crypto-assets locked (TVL) in smart contracts.[14] The TVL indicator is used by market participants to measure the performance of all protocols. The TVL shows the degree of liquidity available to smart contracts, i.e. the extent to which users with crypto-assets that can be locked on platforms (supply side) participate in the DeFi ecosystem. This also means that TVL concurrently expresses supply-side confidence in the sector (*Outumuro 2020*). According to the site, the USD-denominated amount of crypto-assets locked in the DeFi ecosystem rose sharply from an initial value of USD 4 in August 2017 until 15 February 2020, when it peaked at around USD 1.24 billion. Subsequently, with market panic over the coronavirus epidemic, it suddenly fell very sharply to USD 487 million. It seems that it was followed by consolidation

[12] https://defimarketcap.io/ records in total 3,802 crypto-assets attributed to DeFi.
[13] https://www.coingecko.com/en/defi
[14] The methodology of the calculation is simple: it sums up the amount of actual collateral in each smart contract examined and then it multiplies this by the spot market commodity selling price denominated in USD. Concerns have recently been raised about the accuracy of the methodology, as some collateral may be taken into account more than once (*Dale 2020b*).

and then, after 15 June 2020,[15] its value suddenly surged due to market sentiment about the emergence and spread of yield farming. All this means that in 2020, the value of the TVL indicator grew to more than 20 times its value (*Outumuro 2020*). At the close of this study, the total value locked in DeFi was close to USD 30 billion (see *Figure 2*).

Figure 2
Total value locked in DeFi in USD (22 August 2017 – 3 February 2021)



Source: defipulse.com

Still, according to DappRadar, the TVL indicator used by defipulse can be misleading. *Outumuro* (*2020*) found that the indicator does not take into consideration the changes on the demand side, especially in the case of lending and borrowing platforms. On the other hand, the value of TVL is fundamentally affected by price changes of crypto-assets locked as collateral. By eliminating the effects of price changes, a more accurate picture of TVL can be obtained (*Abugov 2020*). For our part, we do not wish to take sides in the professional discussions regarding the calculation of TVL, however, we indicate that, according to the DappRadar methodology available at dappradar.com/defi, the adjusted value of TVL after

[15] On that day, the distribution of the secondary token of the Compound liquidity pool type lending and borrowing platform, the COMP, started. Similarly to COMP, several decentralized protocols created and began distributing their own secondary tokens. Thus, with the rapid spread of liquidity mining and yield farming, the value of sources locked in DeFi suddenly skyrocketed (*Wan 2020; Keoun – Godbole 2020*).

eliminating the price effects stood at USD 15.56 billion on 3 February 2021. For the sake of comparison, it is also worth noting that the value of the above TVL indicators calculated in different ways is approximately 9.36–17.98 per cent of the aggregate assets of Hungarian credit institutions measured on 31 December 2020 (*MNB 2021*). The amount of funds locked in DeFi in USD has undoubtedly shown a significant increase to date, but the current volume of locked funds is considered quite small, compared to the estimated size of global fixed income markets estimated to be worth USD 250 trillion (*Binance Research 2020*).

Amler et al. (*2021*) highlight that the increase of the TVL index stems on the one hand from reinvested profits and exchange rate gains, and on the other hand from a dynamic increase in the number of users. The latter trend is also supported by Chen's time series[16] published on the website of Dune Analytics, which found that the number of individual wallets[17] interacting with DeFi protocols increased by 1,000 per cent in 2020. Currently, the number of individual wallets exceeds 1.2 million.

6. Benefits and opportunities of DeFi

DeFi platforms are easily accessible for all users, fast, simple and easy to use, and each platform is interoperable; therefore, the level of customer experience is high. In the case of complex transactions in particular, users can create the order of transactions themselves, set the amount of the transaction cost to be used, and customize the transactions to be performed. In addition, it is important to emphasize the unprecedented high level of transparency: all transactions and smart contracts can be publicly monitored and verified. In contrast to traditional financial systems, this can provide an opportunity to avoid or mitigate risks before they occur.

An additional benefit of the ecosystem is increased efficiency. DeFi replaces the central counterparties trusted by market participants with smart contracts that are theoretically capable of performing the functions of central counterparties, whether it is about custody, escrow agents or performing clearing and settlement. Such solutions, in any case in theory, pose a much lower counterparty risk, and make transactions more efficient overall (*Schär 2020*). A lower need for trust can at the same time reduce regulatory pressure and the need for third-party audits.

[16] https://duneanalytics.com/rchen8/defi-users-over-time
[17] This number does not clearly match the number of users, as a single user can have multiple wallets.

Transparency is further enhanced by the fact that a permissionless blockchain is immutable and resistant to alteration attempts by third parties. It follows from the permissionless nature that users, or developers of DeFi protocols, are currently free to enter the ecosystem without permission from government or market players (*John 2020*).

DeFi also allows users to apply liquidity mining, yield farming and arbitrage strategies incorporating them; therefore it can also be used for investment purposes. Interest is due to users for locking their crypto-assets. In addition to possible "cash flows", holders of secondary tokens can realize exchange rate gains on their crypto-assets as the value of the platform increases. At present, DeFi is undoubtedly less of an alternative to the traditional financial system for users in developed economies compared to emerging economies such as South America, where due to the difficult economic situation, Dai stablecoin, soft-pegged to the USD, has become a popular savings vehicle (*Maker Blog 2020c*).

Comparing the financial transactions that can be conducted in the traditional financial system and DeFi, we find that both areas aim to offer financial products and services to users. The key difference between the two areas stems, on the one hand, from the fact that in the case of the former, users trust the "bank and its related actors", while in the case of DeFi, their trust is vested in the technology and protocols used on blockchains (*Iredale 2020*). On the other hand, the "scene" of the two areas is separate. While traditional financial system is present in the real economy, DeFi builds on the blockchains and manages value there. *Table 1* compares some features of the traditional financial system and DeFi.

Table 1
A comparison of some features of the traditional financial system and DeFi

Characteristics	Traditional financial system	DeFi
Scope of services provided	Full range of financial services	Currently limited range of financial services
Scope of targeted users	Restricted (typically local)	Unlimited (global)
User group	Users in the retail, corporate and public sectors	Predominantly retail, but also the corporate sector has started to open up to the area
Business models	Combining traditional and platform-based business models	New, hybrid business models (e.g. AMM) also offering platform-based services
Control over assets	Financial institutions act as custodians	Users manage their assets (non-custodial wallet)
Availability	Typically limited in terms of time (except for payment systems e.g.)	Always available
Procedures prior to the actual transaction	Occur almost without exception	Users only interact with the protocol for the duration of the transaction
Actor who decides on the transaction outcomes, executes, and monitors the transactions	Within the legal framework, subject to the strength of industry competition, is determined by the institution (with limited influence of the user)	Smart contracts (the transactions are executed in a deterministic manner)
Mutability	Possible	Basically excluded
Reversibility	Settlement finality is a requirement, but applicable rules and regulations may allow the reversibility of transactions	Irreversible
Transaction speed	Variable (fast turnaround time for everyday transactions, longer turnaround time for more significant transactions)	Variable (increased turnaround times due to the operation of blockchains, but promptness is rather typical)
Level of liquidity	Due to prudential rules, it is typically high	Volatile
Transparency	Details of transactions and the IT infrastructure used are typically not public	Transaction data and protocol source codes are public
KYC	Mandatory, client data is managed by the institution. Only identified clients can perform transactions.	Occasionally, however it is not required at the protocol level because it typically occurs when using the wallet service or exchange. In DeFi transactions, users use pseudonym addresses. Their identity remains unknown until the relevant information is revealed.
Fees and costs	Fees and costs are typically higher (but there is scope for reduction and due to digitalisation, this may be realized even in the shorter term)	Rather lower fees (possibly high gas costs)
Determination of fees and costs	Within the legal framework, subject to the strength of industry competition, is determined by the institution	The influence of individuals on the fees and cost structure is smaller. They are shaped by supply and demand due to decentralization, under technical conditions.
IT security	High due to regulation	Lower, but can be enhanced by using (external) audits
Level of customer experience (UI / UX)	High	High
Customer Complaint Management	Ensured	Rather difficult

Source: Plotted based on Borealis (2020), Bybit Learn (2020), Iredale (2020) and Amler et al. (2021)

With proper development of the technology, DeFi may evolve into one of the most significant blockchain sectors. This could create the opportunity to reach billions of users all over the planet and provide access to basic financial services and new, complex products at low fees and interest rates. It can also lead to a paradigm shift in the field of financial services (*Amler et al. 2021*). The paradigm shift could encourage the centralized financial and DeFi ecosystem to cooperate, thus leading to the emergence of new business models in the future that are more efficient and secure than existing ones (*Maker Blog 2020a*). The first signs of cooperation were already seen in the last quarter of 2020. Institutional investors' interest in crypto-assets has increased (*Sinclair 2020; Godbole 2020*). With regard to stablecoins, it can also be observed that an increasing number of issuers are seeking authorization to conduct financial services (*Kabompo Holdings, Ltd. 2020*) or are about to issue stablecoins in the possession of a banking license (*Allison 2020*). Finally, it is important to note that initiatives have emerged that seek to make DeFi functions available to traditional financial institutions and institutional investors (*Curv DeFi 2020*). All these confirm that cooperation and joint development of the two areas can be reasonably expected. At the same time, in the long run, the development of DeFi may also encourage incumbent actors to increase their level of digitization and to enhance the customer experience they offer.

7. Fundamental risk factors of DeFi

DeFi is also not a risk-free sector: in fact, *Acheson* (*2020*) considers it clearly terrifying "*a financial system without oversight or an off switch* (as it) *is even more vulnerable to manipulation and error than one that is legally accountable to the user and can be fixed when things go wrong"*. Acheson points out that the source of risk in the context of DeFi is primarily the technology independent and trustless character, which is further exacerbated by regulatory uncertainties. These risks became a reality in 2020 during attacks against decentralized trading platforms. During the (at least) three attacks against bZx (Fulcrum), attackers acquired a total of approximately USD 9 million worth of crypto-assets, of which USD 8 million was returned (*Khatri 2020a; 2020b; 2020c; 2020e*). Moreover, on 19 April 2020, crypto-assets equivalent to USD 25 million – 99 per cent of the platform's assets – were appropriated by a hacker from the dForce (Lendf.me) lending and borrowing platform (*Foxley – De 2020*).

Among the main risks, we can generally distinguish blockchain-related and market risks, as well as DeFi-specific risks. The latter group can be further subdivided into operational risks, including consumer protection risks, as well as regulatory and compliance risks.

7.1. Examination of the key risks associated with blockchains in relation to DeFi

Among the risks associated with blockchain, first the findings of *Hay* (*2019*) and *Amler et al.* (*2021*) on decentralization are worth mentioning, according to which each application is only as secure and scalable as the underlying blockchain is. Scalability constraints (e.g. limited block size), especially for Ethereum as the most important blockchain for DeFi, can cause interruptions in the execution of transactions. Scalability constraints result from time to time in increased transaction costs. On Ethereum, TRON or TomoChain blockchains, senders must also pay transaction fees, so called gas or energy for the execution of transactions, for example for the transfer of tokens. Gas prices are a function of real-time market demand and supply (*Binance Research 2019a*).

Ethereum is particularly notorious for its significant gas costs.[18] The fees to be paid in the ETH are used by Ethereum, *inter alia*, to reward nodes that validate transactions. Due to the limitations of Ethereum's scalability, increased network traffic (network congestions)[19] can significantly drive up gas costs, and consequently, a higher fee will be required to validate a transaction. Increased traffic can also cause congestion in the network. Since transactions are ranked based on gas prices, transactions with higher unit costs take precedence over those with lower ones. The consequence of this is that, if a given transaction is not at the top of the ranking, it is either executed late or not executed at all.[20] In order to execute the transaction, the user has the opportunity to optimize it, in particular to adjust the gas price so that the transaction is executed for sure. For example, MetaMask wallet or EthGasStation transaction fee calculator can help with this. This clearly results in higher gas costs on the user side.

Based on data from Dune Analytics, *Amler et al.* (*2021*) pointed out that the emergence and popularity of DeFi has fundamentally influenced the rise in gas prices in the Ethereum network. Estimating the average unit value of gas required for DeFi transactions to be between 40 and 540 gwei, the authors found that the value of gas burnt daily in the second half of 2020 exceeded USD 1.5 million. As a consequence of this, the dramatic increase in gas prices due to the spike in demand for DeFi applications made it impossible for many non-DeFi applications to operate.

Binance Research (*2019a*) found that there is no doubt that some transaction fee needs to be set, but overly high fees deter users from using blockchain. This is further exacerbated by the fact that on some blockchains, transaction fees can

[18] For each transaction, the maximum amount of gas willing to be spent must be set out (gas limit). The price of a single gas unit is denominated in gwei (1 gwei = 10^{-8} ETH) (gas price). The product of the two shows how much gwei is required for the transaction.
[19] The reason for this may be, for example, market turbulence due to the fall in the ETH.
[20] Depending on the protocol, non-validated transactions will either be deleted after a specified period of time or "stuck" and will be pending until the user re-initiates the transaction with the appropriate gas price.

only be paid in a single asset. There is a trend towards the continuous emergence of second layer solutions that seek to increase blockchain scalability in order to ensure network traffic, while also seeking to reduce on-chain fees (e.g. Polygon). Other blockchains allow users to pay transaction fees in any valuable asset. It is also important to note that the developers of Ethereum have developed a blockchain reform, Ethereum 2.0, which is currently being gradually implemented. Ethereum 2.0 aims to eliminate, or at least mitigate, the gas problem observed with blockchains by using new scalability solutions (*Edgington 2020*).

7.2. Market risks

In the context of market risks, it is obvious to refer to the volatility of crypto-assets.[21] This affects the DeFi ecosystem in two ways. On the one hand, the price of crypto-assets (notably secondary tokens) issued by DeFi protocols and applications can fluctuate extremely, similarly to well-known crypto-assets. On the on the other hand, the price changes of crypto-assets locked as collateral fundamentally affect the position of the user, which can even lead to the loss of the entire collateral in the event of market turmoil.

As shown in *Section 4.2.*, the DeFi sector takes advantage of network effects for growth. The continuously emerging, new but often immature DApps use social media for their marketing activities and are offered by influencers in various forums to a targeted, primarily retail user groups. With the emergence of yield farming and liquidity mining, this type of influence has resulted in a bubble-like situation in the sector, especially in the secondary token markets. Unrealistically high daily returns were observed, which may not have reflected the future potential of the DApps behind the assets. Due to certain developers with reserved holdings in secondary tokens selling out their long positions, a protocol failure or a hacker attack, prices plummeted and token holders suffered very high losses (*Foxley 2020b*; *Palmer – De 2020*). Such behaviours show a high degree of similarity to unwanted pump & dump-type market manipulations or other frauds and scams in capital markets (*Amler et al. 2021*; *UKNF 2021*). As it is currently quite difficult to deal with this type of behaviour, when using DeFi for investment purposes, investors have to mitigate the market risks by applying different risk management solutions (e.g. diversification, hedging).

7.3. Specific risks of DeFi

It is clear that interdependence is one of the most attractive features of DeFi, but it is precisely this that also poses a key risk. Due to interdependence, shocks in one layer can spread through the entire structure and render the chain of overlapping tokens worthless (*Schär 2020; Amler et al. 2021*). The fact that individual protocols

[21] For the purposes of this study, volatility shall mean the price fluctuation.

and applications are reliant on the external data supplied by oracles can also pose a risk of interdependence. Improper data supply, for example if the oracles report incorrect price feed data to the protocols due to the occurrence of some operational risk (e.g. manipulation or failure to obtain data), can result in substantial damage.

As a result of *targeted manipulation*, perpetrators can obtain crypto-assets from the individual platforms in an unfair manner. This risk became apparent on 14 and 18 February 2020 as a result of hacker attacks against bZx DEX. Both attacks applied the same principle. After borrowing the crypto-assets, the perpetrators used various leveraged trades to influence the price feed of the oracle used by the lending and borrowing platform (*Foxley 2020a*), then exchanged their assets to the original asset of the loan and made a significant profit (approximately USD 1 million) after repaying the loan. Since the source of profit was the liquidity pooled by other users, the perpetrators may have harmed ultimately other users with the attacks. The attacks disabled the so-called sanity check function of bZx protocol, which would have been responsible for verifying that after the swap the position will not be defaulted. In both cases, the perpetrators exploited the bugs of the smart contract during the attack (*PeckShield 2020*). In addition, the above attacks may also affect the price of the crypto-assets involved, resulting in heavy losses to their holders.

In order to mitigate the above risks, it is essential that DeFi platforms use more well-functioning, transparent and reliable oracles (*Amler et al. 2021; Liu et al. 2020*). It is a tendency for participants to use the oracles offered by centralized trading platforms (e.g. Coinbase Oracle)[22] (*Anisimov – Youngblood 2020*), in addition to decentralized oracles (e.g. Chainlink, Uniswap, etc.).

Transactions concluded on blockchains are irreversible and are executed by smart contracts in a predetermined way. In this context, smart contract vulnerabilities pose significant operational and security risks. The study previously stated that the source codes of DeFi protocols and previous transactions are public, and thus anyone can access them. This also opens up opportunities to exploit the weaknesses and bugs in smart contracts (*Amler et al. 2021*). Hackers could siphon off the assets managed by the smart contract from the system, cause chaos, and even cause the system to collapse completely. As a result of a hacker attack, losses can be very high for both the platforms and the users. But there is no need for a hacker attack, the *code* may simply be *faulty*. For example, in the case of the YAM stablecoin initiative, the market capitalization of the secondary token issued by the platform (YAM) lost ninety per cent of its value in thirty minutes because developers disclosed that a bug was found in the system (*Khatri 2020d*). Average users are not expected to understand the exact operation of smart contracts, to "read the code", and thus they may not be familiar with the operation of the platform and its possible limitations,

[22] Compound, for example, uses also Coinbase Oracle.

and this carries the risk of suffering losses. The existence of so-called administrator or *admin keys* can also pose operational risks. Those who have this can shut off the given DeFi initiative. *Obtaining and use of the keys by unauthorized parties* can have unpredictable consequences for a project. Requiring a multiple signature (multi-sig) upon use, as well as a timelocks may mitigate certain operational risks. A high concentration of secondary tokens may also pose operational risks as it would enable a person or persons to have decisive influence over the operation of the protocol.

The constant threats are forcing platforms to stay continuously up to date in terms of security. *Amler et al.* (*2021:5*) consider the "*using well-known design patterns and best practices*" as a good starting point for mitigating such IT risks. In addition, professional organizations conducting audits (e.g. Open Zeppelin or Trail of Bits) and other developers have appeared, who publish the results of their investigations in various forums. In our view, this type of risk management is important for mitigating IT and operational risks, but due to its limited nature, it cannot completely eliminate uncertainty.

7.4. Regulatory and compliance risks

According to the DeFi principle, "*the code is the law*". It is precisely the aim of the movement that there should be no need for a central participant to settle disputes, etc. This role is fulfilled by a transparent smart contract, and optimally each participant receives the expected outcome. Potential regulation may conflict with the DeFi's decentralization efforts. Because of the "bridge-building" efforts between DeFi and traditional finance, it is not unprecedented for a regulated institution to enter the market of DeFi services and to create new products there.[23] In view of this, the regulatory and compliance risks of DeFi cannot be circumvented.

Two simple questions used in relation to centralized entities can help reveal the risks involved with DeFi. Who or what, where and based on what can be held liable, i.e. is there a person behind the protocol who can be held accountable and from whom damages can be claimed? Protocols do not have an organization legally recognized by a jurisdiction but governed by smart contracts. Protocols are developed and supervised primarily by one or more developers. Protocols that have become DAOs consist of rules converted into pre-defined and transparent computer codes, which are governed by a community of secondary token holders or by algorithms, for a specific purpose. This also means that if the organization is not a legal entity, claims cannot, or only to a limited extent, brought against it. Certainly organizations of various legal types may be related to the platforms, but the enforcement of

[23] It is arguable that the deposit acceptance and lending provided by the centralized entity denominated in and or secured by crypto-assets can be considered part of DeFi. For our part, we do not want to take a position on this, but it can be stated that new, "hybrid" business models have also emerged as a result of DeFi.

claims against them or the developers could only be achieved indirectly at best, and the outcome is rather uncertain. Legislative provisions by analogy with piercing the corporate veil, pursuant to which programmers and developers who create and supervise the DeFi protocol are ultimately responsible for its operation might bring some legal certainly, but also could have quite far-reaching consequences and even set the sector back in development. *The lack of a directly accountable entity is considered to be DeFi's most significant regulatory risk.*

To answer the "where" question, it is important to highlight that DeFi, cannot always be attached to states, as opposed to the institutions that make up the traditional financial intermediation system. Due to the novelty of the area and the lack of a legally established organizations, the international division of tasks (jurisdiction) between the relevant national competent authorities has not developed and it is questionable whether it can be established at all. For example, it can occur that a multi-country activity is subject to prior licencing, in which case it is questionable which supervisory authority should authorize and supervise the activity (*Zetzsche et al. 2020*). Similarly, it remain unclear where the damaged user can turn to complain or seek redress.

In the financial markets, especially in the European Union, the *principle of the same activity, same risks, same regulation* is accepted, in order to minimize the possibility of regulatory arbitrage and create a level playing field for market participants.[24] It is a question of whether the activity of the DeFi protocols can be classified as a regulated activity (e.g. deposit acceptance, lending or insurance). At present, they cannot or will not be seamlessly qualified. For activities not subject to financial regulation, only general standards, such as general consumer protection rules, can be applied. Contractual provisions on exclusive jurisdiction and applicable law may render the enforcement of users' claims more difficult.

Whether a particular business model is subject to existing regulation must either be enshrined in law or determined by the regulatory authorities. A good example of this is the case of the tokenised fund type of stablecoins.[25] Some of the tokenised funds may qualify as electronic money. It also implies that platforms engaged in certain business activities involving tokenised funds may be subject to prior regulatory authorisation (e.g. deposit acceptance, lending). As the activity is carried out by computer code, it is yet unclear which participant should be obliged to obtain it or, in the lack of that, to cease the activity.

[24] Some question the application of the principle, stressing that the risks involved may vary depending on the entity performing the activity (*Restoy 2020*).

[25] Tokenised funds are *"units of monetary value that are stored electronically in a distributed ledger to represent a claim on the issuer and are issued, on receipt of funds, for the purpose of making payment transactions to persons other than the issuer"* (*Bullmann – Klemm – Pinna 2019:12*).

Moreover, DeFi protocols provide services related to crypto-assets, so the regulatory classification of the individual services should include the legal classification of crypto-assets affected. Namely, as stated in *Section 4.1,* DeFi's asset layer consists of the crypto-assets created by each protocol. Certain crypto-assets are likely fall into the regulated sphere (financial instruments, electronic money), although not "gap-free". Indeed, the crypto-assets that do not fall within the scope of existing financial regulation are left unaddressed.

Owing to legal uncertainty, users typically attempt to enforce damages due to the occurrence of risks (e.g. hacker attacks) in some manner by using *social media*. Users go public with their statements and claims attempting to persuade platform developers or affected users to follow the behaviour they believe is correct. This type of pressure from a large number of users ("*comment fights*") may be suitable to achieve the desired goal (*Palmer – De 2020*).

Pricing of regulatory and compliance risks may also result in higher transaction fees for certain platforms. The tax assessment of DeFi platforms, especially which state they are subject to taxation also represent a grey area.

Regulatory efforts[26] have been made to reduce regulatory uncertainty, especially concerning stablecoins, but it is remain to be seen whether they will achieve the desired result. Along with these, it is a step forward that regulators have recognized the importance of the area and are examining the possibility of regulation.

8. Results and findings

The study has sought to underline that DeFi could represent a new paradigm in the field of financial services and has the potential to create a truly open, transparent and robust infrastructure for financial services. Due to the interoperability of the protocols, anyone can check all of the transactions and analyse transaction data and draw conclusions from them for the future. One of the findings of the study is that *DeFi puts the data of all financial transactions in the hands of users and it is solely up to them how deeply they process them*. It does all of this in a digital environment where the user experience (UX) is considered to be especially good.

DeFi has launched a new wave of innovation, creating "trustless" versions of traditional financial systems on the one hand, and on the other hand offering *new solutions (e.g. liquidity pools, stablecoins, etc.) that are unthinkable without a public blockchain*.

[26] The Stablecoin Tethering and Bank Licensing Enforcement Act in the USA and the draft regulation of Markets in Crypto-assets in the EU.

The previously mentioned risks, often due to the immaturity of the sector, may decline over time by virtue of development. *With the emergence of more and more products, the range and quality of financial services available to users is also expanding.* At the same time, market participants need to be aware of the risks that have not yet been identified due to extreme innovation and relatively low utilization so far. We should also realise that the concept of decentralization can sometimes be misleading, as there may be actors who are able to access the system in some way (e.g. with admin keys), whether to update a smart contract or initiate an emergency shutdown. It needs to be seen that there is still a need for trust in the system and, as previously emphasized, the ratio of centralization to decentralization may vary from protocol to protocol.

The emergence of DeFi may also be a wake-up call for incumbent institutions. In our view, DeFi and the traditional financial system are not "*fire and water*". DeFi solutions may be reflected in centralized FinTech structures, and even organizations such as the Chicago DeFi Alliance see DeFi solutions as the way out of the recession caused by the coronavirus and consider the area concerned to be a possible path for future financial developments. The realization of this can be facilitated if incumbent participants become more open to the DeFi sector and, as far as possible, show more flexibility in their cooperation.

With proper development of the technology, in particular if scalability issues can be resolved, DeFi can grow into one of the most significant blockchain sectors. This could create an opportunity for DeFi to reach even a wide range of users and ensure access to basic financial services, while also leading to a paradigm shift in the area concerned. And this could also encourage players in the centralized financial system to create more efficient and secure business models than the existing ones, or just to seek partnerships with DeFi players.

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Searching for a Way Out of the Labyrinth of Digital Financial Innovations – The Trap of Regulatory Challenges in the Digital Financial System*

János Müller – Ádám Kerényi

We are monitoring the regulatory tasks and needs in relation to digital financial innovations, which are emerging at a revolutionary pace in the financial system. In the digital age, it is necessary to create the conditions for competitiveness and security in the financial intermediary system. To understand this, we trace the process of how regulators move from a big bang-like market emergence through awakening and recognition to a confrontation triggering a need to act. This is followed by the period of task definition. Effective regulation requires both an analysis of the lessons learned from the period behind us and an outline of a possible vision for the financial intermediary system. A twofold task must be carried out: competitiveness requires the smooth progress of digital development, while the functioning of the financial intermediary system must not be impaired by more favourable operating conditions for digital financial innovations. The principle of "same activity, same regulation" needs to be enforced. Regulation must achieve a balance between these two interests, the absence of which results in regulatory arbitrage and asymmetry. Technological innovations serving payment services, artificial intelligence regulation and data protection need to be controlled. The process of searching for solutions and the desired regulation has been disrupted by the global COVID-19 pandemic, the economic and financial consequences of which have accelerated some stages of this process, while elsewhere they have had a slowing impact.

Journal of Economic Literature (JEL) codes: E58, G18, H21, O16, O36, O38

Keywords: FinTech/BigTech regulation, arbitrage, asymmetry, data-driven process, vision, taxation, social impacts

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1. Introduction

The disruptive effects of the Fourth Industrial Revolution have also affected the financial and banking systems in the past decade. In the second half of that period, so many profound changes took place that it would have taken as much as fifty years to adopt and process them during the previous revolutions.

It was necessary to realise that the progress of innovative digital financial developments was unstoppable and their existence and support constituted an essential condition for ensuring competitiveness and sustainable economic growth. At the same time, the advance of digital innovations in the financial market was so rapid, to the degree of even jeopardising stability after 2015, that their impact could be described as a "big bang". In this situation, one of the fundamental issue was to ensure the stability and the sustainable, competitive and profitable development of the financial intermediary system, i.e. the banking system. The process was multi-faceted: in addition to FinTech-type service providers, large BigTech companies, FinTech unicorns and open banking appeared, along with the technologies required to operate these.

This process reached a point where warning signs emerged, with the manifestation of new types of risks that brought to the surface or foreshadowed systemic risks for incumbent banks which form the backbone of the financial intermediary system.

In our analysis, we stress the need to examine the situation as part of this process, in order to ensure security in the future. We show that, by the end of the previous decade, financial regulators and supervisors had worked out exactly how to support processes that strengthen competitiveness and how to amend regulations in order to ensure the security of the entire financial and banking system. International financial organisations have unanimously called for the harmonised international regulation of digital financial services. The principle of "same activity, same regulation" that is deemed necessary has not yet been implemented. Preserving competitiveness and financial stability requires regulation that provides a balance between these two interests, while regulatory arbitrage and asymmetry have emerged.

To effectively address this situation, it was necessary to analyse the financial market of the future and its various possible forms, and to assess the social and consumer impacts of digital financial innovations. Achieving these goals would preserve the competitiveness of the financial sector as a whole, ensuring the conditions necessary for incumbent banks catch up in digital terms and for the companies representing digital financial innovation to hold a share of the financial market which is not greater than optimal. Several different digital development scenarios (such as central bank digital currencies [CBDC], cryptocurrencies, crowdfunding) may influence possible regulatory symmetry, the realisation of a level playing field

and the vision of the money market, but presenting these scenarios falls outside of the scope of this analysis.

2. Stages of the FinTech phenomenon: market entry, the "big bang", recognition and confrontation

The 2008 international financial crisis marked the beginning of a new chapter in the development of banking. It highlighted all of the shortcomings (including the not always harmonious cooperation between monetary and fiscal policies, in several cases) that paved the way for a crisis which caused severe damage and shook the whole system. A comprehensive arsenal of banking regulatory tools was elaborated at the international and national level to overcome the impacts of the crisis and restore the financial system. Within five to six years after the outbreak of the crisis, the banking system was restored to normal functioning, and in retrospect, we can conclude that the original mission of the banks and the traditional nature of their operations have not changed. The tasks of human-centred operation, maximum protection of banking secrets and client data, value preservation and value creation and financing sustainable economic growth have remained.

Digital innovations that fundamentally challenged the banking sector and were sometimes disruptive began to appear around the middle of the past decade. This phenomenon can be characterised as follows: FinTech solutions representing digital innovations burst into the market of incumbent banks, in a process that was so fast and so profound that it can be referred to as a *"big bang"* (*Barberis 2020*).

During this period, FinTech-type financial innovations were greeted with enthusiasm. Economic actors, central banks and regulators all welcomed the fact that incumbent banks had received competitors, which motivated them to develop their operations and forced them to reduce their costs. Incumbent banks' attitudes were also not critical, as FinTech enterprises – which mostly provided payment services – were not considered to be real challengers at the time.

Following the international financial crisis, the primary task of incumbent banks was to repair the damage caused by the crisis and to comply with the huge number of regulatory measures introduced due to the crisis. As a result, until the middle of the last decade, they lagged behind in the application and introduction of digital financial innovations and reacted late. This created an attractive space to be occupied in the financial market.

In addition to the positive reception, a number of favourable conditions facilitated the extremely rapid development of FinTech services. Conditions for founding start-ups were simple, with few obstacles: outfitted with just a little capital, it was possible to launch an activity that could quickly generate significant revenues with

high turnover. It could be said that regulation was too lax: these enterprises were not considered to be financial institutions. Furthermore, enterprises of this type were helped and supported in a number of ways (regulatory sandboxes, innovation hubs).[1] All of this was reinforced by the realisation that the support for and inclusion of digital development is an important condition for the economic competitiveness of the European Union and its member states.

We consider this stage of development as recognition. During the period of recognition, there was already a need to regulate digital innovation processes. To achieve this, the question of what to regulate had to be answered. Due to the rapid development and varied avenues of digital innovation, it was not possible to formulate a precise definition of FinTech activity. Consequently, even now the definition of FinTech-type digital activities remains loose and inclusive. Thus, we also apply this umbrella-type, broader definition in examining the search for digital innovation regulation in our analysis.

Within a short period of time, digital developments had an unprecedented impact on the human resources side of the banking sector. Incumbent banks needed staff members with new skills and knowledge, while they had to lay off many colleagues who had ensured previous banking operations. During the period under review, a number of analyses showed that global banks were also forced to significantly reduce their staff levels (excluding China) (see *Table 1*). Thus, FinTech competition forced them not only to develop technology and innovation, but also to provide new types of human resources.

Table 1
Number of bank employees per 100,000 inhabitants

	2004	2006	2008	2010	2012	2014	2016
Belgium	666	631	603	555	534	496	
France	638	657	693	661	657	634	634
Germany	852	827	822	804	807	790	
Italy	585	584	576	542	521	493	487
Spain	557	573	586	552	495	438	407
United Kingdom	644	632	644	609	567	559	
United States of America	716	740	708	675	672	643	635
Japan	209	202	219	223	219	217	
Australia	683	720	722	674	627	651	654
China	176	208	205	223	248	275	296

Source: Based on BIS (2018) data

[1] It should be noted that it was possible to use these forms of support in several countries, in principle by incumbent banks or financial service providers as well.

In addition to employees, the number of banks fell sharply (*Table 2*).

Table 2
Number of banks

	2004	2006	2008	2010	2012	2014	2016
Belgium	104	105	107	107	104	103	90
France	820	763	658	638	611	563	529
Germany	2,400	2,301	2,169	2,093	2,053	1,990	1,888
Italy	778	793	799	760	706	664	604
Spain	266	271	280	274	249	219	206
United States of America	8,976	8,680	8,305	7,658	7,083	6,509	5,913
Japan	407	396	387	379	377	373	370
Australia	50	53	55	54	66	70	82
China	88,150	19,797	5,634	3,769	3,747	4,089	4,398

Source: Based on BIS (2018) data

In the second half of the 2010s, the actors, regulators and supervisors in the financial intermediary system reached a common agreement that this process was unstoppable. The time had come for recognition and confronting the challenges of the situation.

Rectifying the lack of regulation and the need to do so is justified by the fact that the emergence of FinTech-type services has both accelerated access to financial services and been able to disrupt traditional financial processes. These developments generate significant privacy, regulatory and law-enforcement challenges (*Philippon 2020:2*). In addition to the many advantages of digital development, it has become clear what issues need to be resolved by regulators in order to ensure the stability of the financial system. In this process of recognition and confrontation, international financial organisations have also come to understand that the benefits arising from payment services pose risks in terms of operational, data protection capability and the protection of clients' investments. All of this can lead to the effect of digital exclusion (*BIS 2020:1*).

Asymmetry between the operating conditions of the two groups – incumbent banks and digital financial service providers – was already observed at an early stage in their operations. While incumbent banks operated under a strict regulatory regime, FinTech start-ups entering the market essentially "mobilised" client deposits with banks and client funds using innovative digital technologies, primarily by providing payment services. The costs and service fees of these start-ups were extremely low, while incumbent banks bore the costs of safely managing deposits and current account money placed with them, and paid interest on deposits. These resources are available to FinTech enterprises with no cost or fee.

It should be noted that these enterprises are active service providers primarily in the areas of payments and thus their regulatory classification and type of activity is different from that of a credit institution. Recognising this regulatory dilemma, the European Union reaffirmed the existing principle, adopted by most member states, that the same activities should be subject to the same regulation. Application of this principle is not self-evident even for the individual member states, because in many cases the emphasis is on the service, while in other cases it is formulated as a requirement in relation to the activity. It has also been known from the outset that digital financial service providers carry out cross-border activity as well, essentially without regulation, although undoubtedly some of them requested authorisation to do so when registering their activity. The European Central Bank (ECB) has indicated that international cooperation and regulation are necessary to manage the processes, but implementing this has not been feasible to date. It was thus decided that most of the regulation of innovative digital services should remain a national competence. At the same time, it must be understood that Europe has a layered regulatory environment that manages regulatory frameworks in a uniform way; within this, in some cases, there is room for manoeuvre in the member states or a supervisory role at national level, and in several cases, regulations (directives) are applicable at the European level.

The aforementioned asymmetry was exacerbated by the fact that, having overcome the difficulties of the crisis, incumbent banks – lacking an adequate toolkit – responded more slowly to rapid digital processes, and were thus slower to adapt and also slower to create the operating conditions for such processes. Another such factor was the emergence of BigTech service provider companies, which, in addition to payment services, had already been engaged in lending and other banking activities.

3. Future landscape of transformation in the financial intermediary system

In light of the lessons above, it was necessary to decide what operating conditions and regulatory frameworks should be established. In order to ensure stable regulation, the expected vision and social impacts of the financial market had to be assessed, in addition to the already known impacts of digital financial processes. In evaluating the vision, analysts did not focus on the unforeseeable future, but rather on the changes expected in the medium term, examining the set of conditions for the future functioning of the financial market and conceivable alternatives and opportunities for a financial system being transformed by digital development.

At the start of the 2020s, analysts outlined the following identifiable framework conditions for the operation of the financial system:

– The spread and transformative impact of digital processes in the financial sector is unstoppable.

– The primary goal is to make maximum use of the positive impacts they provide.

– The risks of FinTech and other digital services must be identified at the same time, and efforts must be made to filter out these risks and mitigate the negative impacts.

– Identical regulation for the same activity of incumbent banks and FinTech service providers and BigTech service providers entering the market must be ensured, thus creating a level playing field; otherwise the sustainable financing and stability of the economy will be damaged.

– Strong emphasis should be placed on the regulation and monitoring of technological innovations (Distributed Ledger Technology [DLT], Application Programming Interface [API], Biometric and Cloud-Based Technology), artificial intelligence (AI) that enable FinTech-type services, and, along with these, on data protection.

Given the history of economic cycles, it was necessary to prepare for a possible slowdown in economic growth, even for the onset of an international recession. Trade wars, geopolitical tensions and efforts to change international power relations and the prospects of the post-Brexit European Union called for a stable, shock-resistant European economy, with secure and sustainable financing of the economy as a primary requirement. An increasingly important new requirement for this – among many other things – is success in international digital competition.[2]

Along with sustainable financing, in their outline of the future landscape of European financial services, experts highlighted the radical transformation of client preferences and needs, the improvement of so-called client experience and the corresponding transformation of services. As digital financial changes considered revolutionary were already described as disruptive in the initial period, one of the first requirements formulated was that the banking system and incumbent banks must "disrupt" themselves, i.e. banks must develop new business models by necessarily taking into account the impact of financial services and service providers based on technological innovations. These developments were summarised clearly by the BIS Financial Stability Institute, according to which "*FinTech can lead to significant positive development but it transforms financial services and also comes with potential risks to consumers and investors and, more broadly, it may pose a risk*

[2] It should be noted that at the beginning of writing our analysis, the coronavirus pandemic was not yet present in Europe; at that time, we did not yet consider its possible economic and financial impacts.

to financial stability and integrity. Therefore, it is the task of regulators to help bring about positive impacts, while seeking to mitigate these risks" (*FSI 2020:2*).

A precursor of the examined vision was the EU "Payment Services Directive II" (PSD2) introduced in 2019, which obliges incumbent banks to ensure – with the consent of their clients – that their accounts with the bank can be accessed by external third party providers (TPP).

The stated aim of this directive was to strengthen competition in the banking market by involving digital financial service providers. This so-called open banking is indeed disruptive and, at the same time, is one of the building blocks of a subsequent possible digital financial marketplace. Incumbent banks will or may also be actors in this marketplace, but the vision outlined does not provide information as to how and based on what criteria its operation should be regulated. This directive made banks realise that their turnover and revenues were threatened by serious competition, and that they had to accelerate their digital developments. Banks were concerned that the process had started under unequal regulatory conditions, and analysts had identified several potential risk factors. Although third party providers can obtain client account information after a rigorous identification procedure, it is difficult or impossible to verify whether a given TPP has concluded a subcontracting service contract (e.g. digital, innovation applications, new interfaces) with another company, which could allow client data to escape from this circle.

A PWC analysis considers the so-called "amazonisation" to be one of the possible, inevitable financial market developments of the period ahead (*PWC 2019*). The essence of this is the creation of a digital financial marketplace, a client-centric interface where retail and company clients are able to find the products and services they need at the best price and under the most favourable conditions. At the same time, they will perceive the overall assessment of this virtual financial market for them, and the views and comments of searchers. These platforms allow for transparency and comparability. Sophisticated technological solutions open up a new opportunity to distribute and share services. "One-stop shopping" becomes possible, where services can be compared and the selected "financial product" can be obtained in one place. According to PWC's vision, millennials will soon be the dominant actors in the market, forcing a twofold impact: firstly, there is a real need to create an amazonised financial marketplace; secondly, they are consciously monitoring "key performance indicators (KPI)" and can make bilateral financial decisions based on them (*PWC 2019*).

4. Social and consumer impacts of the digitalised financial sector

In examining the vision of the future, we must discuss the social and societal impacts of digital developments affecting the financial sector. In modern economic history, scientists have always been interested in the forces that technological and social innovations and their interaction unleash and how they affect economic growth. Historical experience shows that people have generally been positive about the achievements of modern technology, trusting that they will help them realise their dreams. Let us assume that the digital processes examined are in line with the will of people. The question is, however, whether these developments in the financial sector will, without exception, make our dreams come true. With the help of a few examples, let us review the relationship between the new reality that is dreamt of and the reality after awakening. The first point where changes are profound is the transformation of the traditionally human-centric nature of the banking system. As outlined above, banks' traditional business model was based on human relationships: it was a human-centred, trust-based profession. One important requirement was the physical availability of the bank and in many cases personal contact with the staff. Even before the emergence of FinTech, there were tools to replace personal contacts, but the protection of bank secrecy and the human-centred nature of the business remained the same. Today, by contrast, an increasing proportion of financial transactions cannot be carried out without an internet connection, a computer or a smart phone. In other words, we as clients depend on these devices and the data they use, we are not tied to the bank and we have a different approach to the protection of our valuables and data kept by the bank.

In the period ahead, the banking sector needs to be prepared for the fact that a substantial proportion of its clientele will be millennials (*PWC 2019*). Their financial culture requires digital financial services and they will be the active users of the digital financial marketplace offered by amazonisation. They have no, or minimal, risk sensitivity toward FinTech-type financial services, nor are they bothered by the fact that AI-based programmes profile them, based on the data collected about or from them. In addition, by using this, the appropriate technology programmes will find them in the marketplace with customised offers.

A number of examples and analyses show that banking/financial/payment services are expected and required to have digital applications and to provide – what we call – a new type of "client experience". Speed, instantaneousness and electronic remote administration have come to the fore – and today not just in the case of payment services. At more and more incumbent banks, opening an account no longer requires the presence of the client, the identification of the person or, for example, credit assessment is done using electronic applications. These processes

have two consequences. Firstly, consumers' openness to AI-based services and the need for instantaneousness reduce or obscure risk sensitivity. Secondly, the need and opportunity for personal banking is reduced. The negative consequences of this the former are reflected in the significant amount of damage caused by the activities of larger FinTech-type companies, and in the case of the entry of BigTech-type companies, it is clearly demonstrated that their clients are not aware of the nature of the data use by these companies and its possible negative impacts.

Although these processes have been accelerated by the impacts of the COVID-19 pandemic, this does not mean that personal client relationships or bank branches will not be needed, albeit the latter may only be needed in significantly smaller numbers.

The increasing application and use of services based on digital financial innovations has triggered the need to strengthen digital financial awareness at the national and international levels, primarily for the benefit of consumers but also for service providers, in an effort to reduce the risks in this area. With this in mind, the European Banking Federation has organised its financial awareness cooperation programme,[3] and the Pénz7 (Money Week) of the Hungarian Banking Association and the Financial Compass Foundation have similar objectives.

The next stage of transformation is the growing social impact of BigTech companies, which – based on their trade turnover and the huge amount of data they collect – are entering the lending market more and more aggressively and are able to provide cheap, low-cost credit as their clients pay part of the cost of credit with their data; furthermore, they realise a remarkable part of their profits through the resulting increased trade turnover.

In social financial literacy, the result of this is that when people need credit for higher value purchases, they no longer think of banks, or just banks. Thus, a kind of desirable client experience is realised, either in terms of cash flow or lending, but its price and risk do not yet trigger a bitter awakening.

The order of credit assessment and credit rating is changing. Credit assessment is increasingly performed by computer programmes based on the information and data entered. The quickly obtained result can no longer be questioned by clients: they accept the machine's decision, saying that the machine cannot be biased or inaccurate. The possibility for empathy is excluded from banking operations, although in human-centred incumbent banks it could be part of client relationships – provided that all the rules were adhered to. Similar processes are expected to emerge in asset and wealth management, where investment advice and the "movement" of assets are also performed by AI-based algorithms and robo-advisers.

[3] https://all-digital.org/events/european-money-week/

It is indisputable that digital financial services have many advantages and positive impacts. We should be happy and welcome it if the emerging new world is hopefully better than the old world. At the same time, the following question cannot be avoided: Do digital financial changes always result in better things, or do they also reflect the manipulative impact of revolutionary novelties, along with their risks? Digital financial innovations were initially described as a new normal. Not long thereafter, the question arose as to whether the reality of these changes could be known, how to obtain reliable knowledge, and what the truth was.

We are confronted with a valid question: When most users know and experience only the service side of the digital financial process, does this world of experience lead to reliable knowledge, i.e. the truth about the benefits/risks of the FinTech/BigTech process? Are we able to see into the processes, the maze of data usage, the hidden but existing, potential risks of the system? The incompleteness of reliable knowledge may be indicated by the fact that shortly after its explosive appearance on the market, FinTech was described as "a new normal"; or when one of the tasks of the period ahead was formulated, it was said that digital services should provide a "new client experience". Here is another question: Is it possible that the need and search for a new experience keeps us from learning about the possible risks?

All of these developments will transform the organisational and operational order of incumbent banks, significantly fewer and differently qualified human resources will be needed, and the physical availability of banks is no longer a fundamental requirement.

5. The "Catch-22" of regulating digital financial processes[4]

5.1. Searching for the possibility of a balanced regulation

As a result of the process of confrontation and recognition, regulatory tasks reducing risks and strengthening financial stability and the need for such were clearly identifiable. The primary regulatory task is to strengthen the stability and security of the financial intermediary system, including the prevention of systemic risks, the creation of a level playing field and ensuring the security of data use. One sensitive area of regulatory tasks is to strike a balance between maintaining and even strengthening international competitiveness and minimising the potential risks of digital financial services. Due to their nature and system of tools, these financial services are mostly cross-border in nature.

[4] In the title of this chapter, we refer to the novel "Catch-22" by Joseph Heller and the legendary American film based on it. The expression in the title refers to a situation in which we cannot make the right decision, regardless of which possible solution we choose. Decision-makers must continually strive to strike a balance between multiple, simultaneous challenges.

Regulatory issues need to be examined in parallel with the development process of financial innovations, because although operating licenses or the imposition of certain conditions were in place from the outset, the rapid developments increasingly highlighted the fact that certain forms of conduct or supervisory guidelines, and the fragmented, unequal national regulations were no longer sufficient. At the current stage of development, which we call the period of confrontation in our analysis, the task is specifically to implement the regulatory tasks identified, not only at the national level, but, for example, in the EU at the international level as well.

The fundamental question is whether the desired international regulation, and within it at least a common minimum rule, is achievable, or, as proposed by the ECB, the majority of regulatory tasks should remain a national competence. It has become a generally accepted principle that the same activities should be subject to the same rules, i.e. the operation of incumbent banks and innovative digital financial enterprises should be given a level playing field in the money market. The question rightly arises: If one of the actors receives support from several sides (e.g. permitting the financial activity, tax allowances), however, its operation is not subject to the necessary majority of banking rules, if bank client data become available (albeit conditionally) to FinTech service providers, then how should the implementation of a level playing field begin: by easing banking regulations or by tightening that of the FinTech?

To answer the valid questions, the President of the Hungarian Banking Association gives a clear answer: *"We also like fair competition. Today, foreign financial service providers called FinTechs can operate cheaper than Hungarian banks in certain areas, among other things, because they do not pay the mandatory taxes, i.e. the transaction tax, do not apply data protection and other regulations required of the banking sector, do not maintain a branch network, do not deal with costly, less profitable areas and are not monitored by the MNB."*[5]

The Hungarian Digital Success Programme also envisages the creation of a regulatory balance, aiming, among other things, to establish regulatory frameworks that stimulate both FinTech innovations and the digital developments of incumbent actors in the financial sector, and that are favourable for the competitiveness of the national economic and financial system as well.

Another area of the regulatory trap is the separate or activity-specific joint regulation of digital payment and financial services and the digital technologies (AI, DLT, API) that serves them. Without this, regulation of the operation of the examined activity cannot be considered complete. Without disputing their usefulness and indeed

[5] Radován Jelasity: *Szeretjük a tiszta versenyt* (*We like fair competition*). Piac és Profit, 2020/1. https://piacesprofit.hu/kkv_cegblog/jelasity-radovan-szeretjuk-a-tiszta-versenyt/. Downloaded: 7 June 2020.

confirming it, we can raise the question: When will it be possible to extend the conditions of the desired national and international regulation to this area as well? The control, regulation and supervision of BigTech activity presents a particular challenge, which we will discuss later.

As shown above, by the beginning of the 2020s, sufficient information and experience had been gathered to formulate a realistic vision, on the basis of which regulatory tasks should be defined. In January 2020, the BIS Financial Stability Institute published an analysis reviewing the cross-border requirements of FinTech regulation and summarising the regulatory tasks of FinTech activities and the technologies that served them (*FSI 2020*).

Recognising these requirements, in February 2020, the European Commission (EC) published a data strategy for the digital future of the European Union (*EC 2020a),* based on the then-published "White Paper". Strategic materials outlining Europe's digital vision can provide a background and framework for the development of a regulatory system for digital financial processes in the region. The stated aim of the strategy is to make Europe a globally competitive, value-based and inclusive digital economy and society, ensuring that it maintains its open but rules-based market and continues to work closely with its international partners (*EC 2020b*).

In the context of our analysis, one important objective of the strategy is to "create a genuine European data space, i.e. a single market for data, which would make untapped data available so that it can flow freely within the European Union and between sectors" (*EC 2020a*). This data space can actively contribute to realisation of the amazonisation outlined above.

The above objectives are indisputably important, but they create a sense of absence, as a key element in economy, the financial sector is not mentioned among the sectors listed in the strategy material, furthermore, it is not clear whether AI-systems used in the financial system are considered high-risk, as their regulation is subject to a different jurisdiction. Hopefully, this is the case, where guaranteed human supervision would also be a top priority. It is a positive decision that the objectives of the White Paper should be achieved by the end of the five-year cycle starting in 2020, but this time-frame may prove to be too long, given the speed of digital processes.

The Common European Data Space plans to lay down new rules on cross-border data use and data interoperability. The conditions for data access and data use will be regulated. In the Commission's view, regulatory instruments should ensure the competitiveness of the European Union in the digital sector on the basis of three pillars of activity, namely, by means of *technology for people, a fair and competitive digital economy and a digital and sustainable society.* In this Bermuda

Triangle of regulation, the aforementioned White Paper is of key importance, as it will represent the introduction of the Digital Services Act (DSA), providing a legal framework for data management. Analysing the search for a way out regarding digital regulation, we consider the European Parliament's (EP) recommendations of April 2020 to be an important step forward, in which the EP makes legislative proposals to the EU Commission on digital services to improve the functioning of the single market (*EP 2020*). This also means that the legal regulation of some of the issues affecting our analysis has already started and is in progress. In this regard, we would highlight the proposal for ex-ante regulation of systemic platforms, according to which DSA should *"set up an ex ante mechanism to prevent (instead of merely remedy) market failures caused by* 'systemic operators' *in the digital world, building on the Platform to Business Regulation"* (*EP 2020:17*). Another important element in strengthening balanced European competition rules is the issue of digital taxation, which we will write about later.

In order to move forward, the European Commission set up an expert group (*"Expert Group on Regulatory Obstacles to Financial Innovation – ROFIEG"*), which, at the end of 2019, summarised the regulatory obstacles and assessed what to do in the period ahead. In their report, they note that many of the risks arising from the use of FinTech are not different from those associated with traditional financial services, so it is not possible to draw a clear line between the potential risks of "traditional" and "innovative" financial services. Innovative technologies can both increase and reduce these risks (*ROFIEG 2019*). The risks identified by the expert group can help make the necessary regulatory decisions, and they urge that such decisions be made. For example, it is found that the financial market, like other areas, creates opportunities for activities that are contrary to market integrity (e.g. market manipulation) or for abuses in the form of criminal offences (money laundering, tax evasion, purchase of illegal goods or services, etc.). However, the use of FinTech can also pose entirely new risks, for example: a) If decisions are carried out by AI-based "black box" algorithms without human intervention or which are not understood by clients or supervisors. b) Distributed ledger records or case management blur regulatory and legal responsibilities, which are traditionally based on bilateral agent-agent relationships. However, the expert group has not yet made proposals for specific regulatory decisions.

At the end of the last decade, both the International Monetary Fund and the World Bank dealt extensively with the impacts and benefits of digital financial innovations and the need for their regulation (*IMF 2018*). These two organisations also emphasise the need to find the right balance between financial innovation, the strengthening of competition, commitment to open, free and competitive markets, and addressing the challenges of financial integration, consumer protection and financial stability.

Analysts from these two global financial organisations have called for close international cooperation and coordination to eliminate regulatory deficiencies and avoid risks associated with the decline in regulatory compliance. The report issued by the International Monetary Fund states: *"Many fintech risks might be addressed by existing regulatory frameworks. However, new issues may arise from new firms, products, and activities that lie outside the current regulatory perimeter. This may require the modification and adaptation of regulatory frameworks to contain risks of arbitrage, while recognizing that regulation should remain proportionate to the risks"* (*IMF 2018*).

In addition to the positive aspects of the analyses of the two international organisations, it should be noted that their proposals do not include the appropriation and possible content of specific action, while the risks of disrupting the financial stability and the financial intermediary system are present, i.e. here, too, the dilemma of regulatory arbitrage arises.

In the foregoing, we reviewed in detail the further development options elaborated or proposed by international organisations for proper regulation of the financial sector. As seen, the need to achieve a level playing field is now widely accepted, but substantive decisions were not made on the grounds that efficiency and competition were necessary. This justification also has a self-exculpatory nature, as the issue should be considered in its entirety, including financial services, data management, financial data security, the application of artificial intelligence or robotics. While maintaining the known and desired digital benefits, we should not ignore the risks of fragmenting and dismembering the financial services provided by incumbent banks.

Supporting this line of thought, let us consider the so-called GDPR (General Data Protection Regulation) rule as an example, which is mandatory in the EU for the protection of personal data: pursuant to GDPR, all financial institutions must ensure the protection of client data, giving their clients the absolute right to inspect their data and be in control of them. Then, the EU's payment services regulation PSD2 (Payment Services Directive II) was issued, which (to strengthen competition, as it stated) allows licensed non-banking service providers to access bank client data in order to render their financial and information services. This change in itself had several consequences: it disrupted the financial market, fragmented the former unity of deposit and payment transactions and lending, abolishing one of the main tasks of banks: the exclusive protection of bank secrecy on the basis of client data protection. Namely, in our view, the "utilisation" of client data already held by third party providers cannot be fully controlled; due to the outflow of part of the data volume held by banks, incumbent banks have been put at a remarkable competitive disadvantage vis-à-vis financial innovation digital companies. The term "regulatory arbitrage" fits well with this situation, when the need to strengthen competition and

to control market processes appear again at the same time. The European Banking Authority (*EBA 2020*) has also affirmed the importance of balanced regulation and identified four key pillars: data management; technology infrastructure; organisation and governance; and analytics methodology.

As a new element in digital financial services, central bank digital currency (CBDC) has emerged. Although an analysis of this issue is beyond the scope of this study, we will briefly address it, as its impact on the financial intermediary system will be noteworthy in the near future. The introduction of CBDC may have advantages: it could make the payment system more efficient and cheaper, strengthen economic integration and cross-border payments, and monetary policy could take on a new dimension. At the same time, assessing and managing potential risks in terms of regulation, and thus stability, is a priority. From the point of view of the banking system, the first possible risk is a departure from financial intermediaries, a disintermediation of the normal chain of the financial intermediary system, when clients transfer their deposits with the bank to CBDC holdings. In this situation, banks are forced to pay higher interest rates in order to retain deposits and to raise funds that reduce their profits, which ultimately makes lending more expensive or forces a reduction in collateral.

5.2. The emergence of BigTech – another trap of regulation

Thus, at the beginning of the decade that began in 2020, it can be seen that the disruptive impact of FinTech enterprises in the incumbent banking market has been relatively marginalised, partly due to the digital catching-up of banks. However, BigTech companies appearing in the meantime are breaking into and opening up a breach in the money market.

The next big challenge of regulation, as mentioned above, is the supervision and control of BigTech companies entering the market after the emergence of FinTech financial services. Some of these are capable of disrupting financial markets, sometimes entailing systemic risks. Numerous analyses point to the financial market risks of BigTech-type companies such as Facebook, Google and Amazon. After the big bang of FinTech in the money market, the penetration of BigTech companies into the financial market meant a paradigm shift in terms of regulatory tasks. While FinTech enterprises disrupted the formerly uniform structure of the banking market primarily in the area of payment services using their innovation tools and mainly relying on the data and client bases of incumbent banks, BigTech broke into the market by utilising the already data-driven system of the economy, triggering an ever-deepening transformation process.

BigTech companies have a huge body of data and a large number of users, which allows them to build a “platform strategy”, taking over an increasing proportion

of the tasks of the financial intermediary system. "*In this decade, however, a new type of disruption of the financial system has emerged, which is a platform strategy. BigTech has gained unparalleled experience in this area and has therefore a competitive advantage over incumbent banks. BigTech business models are built on network effects and there is no reason why they should not apply this logic when launching financial services. In other words, while FinTech has brought competition, BigTech will result in concentration"* (*Dahdal et al. 2020:1*).

BigTech companies operating on a network basis with large amounts of data present regulatory authorities with a real challenge. Due to their size, these giant companies represent systemic risks; they are too large for their financial activities to be controlled and regulated by a single jurisdiction. In relation to the data volumes and client access available to them, basically, they do not obtain them through financial activity and client relationship, however, with the approval of their clients or indirectly, and they also have access to bank client data. Due to their amazonised, data network-based activity, information asymmetry is developing between them and incumbent banks, and regulators have so far been unable to find a solution to this competitive disadvantage. In this regard, incumbent banks may have the option of entering the digital financial marketplace, although they may thus open up another data outflow channel. Another realistic scenario is that BigTech platforms will be wedged in between banks and their clients. *"Big Tech firms may become banks and leverage their superior information about consumer preferences, habits, and conduct; they can control the shopping experiences of many consumers. […] They have not only superior big data but also an advantage in terms of the tools (e.g., AI algorithms) used to analyse them in order to understand customers' needs and influence them"* (*OECD 2020:22*). While BigTechs have extensive, up-to-date information on their clients' purchase patterns and preferences, clients only receive information on the services they use and are mostly unaware that they are paying for some of the services with their data. Information asymmetry can also be found between incumbent banks and their clients, usually in favour of the banks, but this is limited by a number of laws, obliging banks to provide as much information as possible. For BigTech companies and their services, there is a cross-border stratification of data protection systems, resulting in fragmentation of the international market. Companies registered in certain countries with limited data protection systems may refuse the operation of other jurisdictions, because they are not subject to the given country's regulation.

One of the key issues in the indispensable regulation of digital financial processes is taxation. In fact, the European Commission has set a target for the taxation of digital giants, where much of the companies' revenue comes from the value generated in the data economy. However, generally, these revenues are not taxed where they are created, which distorts competition and reduces the tax base of the societies.

The European Commission has also proposed a reform of corporate tax rules, whereby profits should be declared and taxed where the given enterprise maintains a significant relationship with users through digital channels. Similarly, discussions are taking place at the international level for a consensus-based, long-term and global solution. According to the schedule adopted by the G20, such a solution should be developed by the end of 2020. Negotiations on the international taxation of the digital economy are led by the Organisation for Economic Co-operation and Development (OECD). At the same time, several member states of the European Union (France, Italy, Spain and Hungary) are planning to introduce targeted taxation on digital giants and would, in principle, support its international extension.

Based on the above, it can be seen that the directions and conditions for the development of balanced regulation have been realised. However, due to the COVID-19 pandemic, in the field of financial regulation, regulatory processes classified as urgent prior to the pandemic, are fading into the background and temporarily slowing down.

5.3. A brief overview of the Hungarian FinTech regulation

Hungarian digital financial processes have followed the developments of the international mainstream in recent years. The start-up conditions were favourable for FinTech start-ups, and they received a number of supports for their growth. The central bank made it possible for digital financial innovations to take advantage of the opportunities offered by the Innovation Hub and the Regulatory Sandbox.

Progress was rapid and fruitful in many respects; by the end of the previous decade, digital innovations became major actors in the financial ecosystem. By 2020, more than a hundred FinTech-type companies were operating successfully in the country. Some of them provide B2C, but most of them provide B2B-type services. It became clear that there was a need for cooperation between ecosystem actors, incumbent banks and companies representing digital innovations.

Realising this, experts developed Hungary's FinTech strategy in May 2019 (*Digitális Jólét Nonprofit Kft 2019*). The strategy within the framework of the Digital Success Programme aims to promote the development of the sector even with budgetary resources and to remove regulations restricting development, whereby innovative technological solutions will result in simpler, cheaper and more convenient administration for clients and increased competitiveness for the economy. A process started, in which the FinTech strategy of the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB) was published in October 2019 (*MNB 2019*). The strategy concerns initiatives within the MNB's remit that encourage the introduction of new services to the market. One of the key elements of this is the need to create a regulatory environment that takes into account changes, supporting positive innovations, while taking effective and rigorous action against excessively risky,

unethical or harmful behaviour in an effort to strike the right balance between these two objectives.

In cooperation with government bodies, in the autumn of 2019 the Hungarian Banking Association elaborated a comprehensive concept supporting digital development, on the basis of which negotiations on the proper functioning of financial innovation services were launched in cooperation with the relevant government bodies. *"The regulatory and supervisory environment will even be decisive for banking digitalisation: if the rules imposed on FinTechs/BigTechs are looser than the ones imposed on banks, digitalisation will take place in a non-level playing field and with more risks for clients than what should be allowed"* (*Becsei et al. 2019:303*).

To achieve the desired, successful digitalisation, the entire financial sector has to confront new challenges. The heads of the Magyar Nemzeti Bank and the Hungarian banks agreed that the big winners of the economic impacts of the COVID-19 pandemic are clearly BigTech companies, which are now able to cover the entire financial value chain and not only have considerable capital but also control massive data assets and are able to enter the financial services market.[6] BigTech companies have an advantage over commercial banks in regulatory arbitrage. The banking sector is an extremely strictly, highly regulated, controlled sector, which entails enormous costs to it. Banks must now compete with these companies in a setting in which they are subject to different rules. It is a common position that a level playing field is needed.

Furthermore, the member banks of the Hungarian Banking Association have drawn up a list of the focal points of digital transition in banking and formulated their proposals in support of digital transition. These include reducing high cash use by digital payment solutions, expanding and optimising digital lending and client service processes, reducing the administrative expenses of bank operations and continuing to strengthen education that incorporates digital finances (*Becsei et al. 2019*).

The Magyar Nemzeti Bank is participating in several international initiatives aimed at regulating the standards of conduct of FinTech processes. A precursor of international regulatory initiatives was the Global Financial Innovation Network (GFIN), which created a cross-border regulatory sandbox, as well as the London-based Financial Conduct Authority (FCA), which aims to establish a link between regulation and fair FinTech regulation (*Müller – Kerényi 2019*). The MNB has joined the GFIN and has a close professional relationship with the FCA.

[6] Nagy, L.N. (2020): *Egyenlő elbánást kérnek a bankok* (*Banks call for equal treatment*). *Világgazdaság*. https://www.vg.hu/vilaggazdasag/vilaggazdasag-penzugy/egyenlo-elbanast-kernek-a-bankok-3100030/. Downloaded: 3 October 2020.

In April 2020, the MNB's FinTech and Digitalisation Report was published (*MNB 2020a*). The document provides an overview of domestic digital processes and classifies the level of digitalisation in the domestic banking sector. It considers the latter to be a good medium level, applying perhaps a too strict standard, because in the last few years the digital capabilities and innovation services of Hungarian banks have taken a remarkable step forward.

The Magyar Nemzeti Bank is closely monitoring the market trading of cryptocurrencies: one indicative step in this regard was the warning issued in connection with the activities of certain FinTech companies operating in the country (*MNB 2020b*). These warnings also contain important indications for the future: They lay down that (1) the MNB only supports the operation of these types of companies if they guarantee financial stability and client security, and (2) it takes decisive action against cases negatively affecting consumers in Hungary, even if – in case of cross-border activities – its supervisory tools are limited.

The above reaffirms that with regard to cases identified in connection with foreign-owned companies, only the supervisory authorities of the home country can act, even if such cases endanger stability or consumer security; the MNB's consumer protection powers are limited.

In April 2020, the Hungarian Fintech Association was established. Its statutes contain the generally accepted objectives of financial associations (*Hungarian Fintech Association 2020*). Start-ups, mature enterprises, incubators and accelerators joining the Hungarian Fintech Association *"agree with the goals of the association, and through their own technology-focused activities, support the functioning of financial service providers and banks in the market (servers), or by means of their innovative solutions have a disruptive business model to meet the financial needs of retail/company clients (challengers)"*[7].

It is thought-provoking that the Hungarian Fintech Association considers incumbent banks to be servers, obviously not referring to the fact that banks are serving their own clients. In the light of this vision, banks should be the "servers" of FinTech companies, presumably to achieve a better client experience. If this is the case, it should appear in the requirement of same regulation.

Due to the COVID-19 pandemic, FinTech processes have continued to accelerate since the beginning of this year in Hungary as well. Among other things, the central bank has already registered five Hungarian companies, together with a company called Koin, which can operate as account information service providers (AISP).[8]

[7] Rácz, G. (2020): *Megkezdi tevékenységét a Magyar Fintech Szövetség* (*The Hungarian Fintech Association has begun its work*). Napi.hu. Downloaded: 7 June 2020.
[8] The AISP has access to the user's payment account balance and transaction data with the user's authorisation. It may use the data to provide additional financial services.

AISP companies not only gain insight into bank clients' account balances, but can also track all of their payments and purchase patterns, which is a way of entering into cooperation agreements with other FinTech service providers, as has been the case with Revolut. Of course, they do not pay a fee to the bank for the use of client data managed by banks and secured, inter alia, by deposit insurance guarantee and for money transfer from there. Thus, open banking continues to expand in Hungary too, along with its advantages and risks due to regulatory gaps.

Based on the above, we can conclude that the development of FinTech and digital innovation in Hungary is moving in the right direction. The MNB, together with the Hungarian Banking Association, is actively following international processes, and has joined some of them, and consultations have begun between the Hungarian banking community and financial government bodies to strengthen digital competitiveness. However, the COVID-19 pandemic temporarily modified the focal points of this process.

6. Summary

The regulatory requirements, goals and aspirations of diversified, digital financial innovations with more and more new elements are constantly spinning like a *perpetuum mobile*. This perpetual-motion "machine" is consuming a lot of energy, however, the question is: How and when will it reach its destination? When talking about regulation and searching for a way out, we are looking for a chain of international, national legislation, central bank or supervisory measures that ensure the same regulation of the same activities in each area of the financial intermediary system, from capital requirements to taxation.

In this process, we have followed the course of digital innovative financial developments, from the big bang through recognition to the confrontation and then, by outlining the future landscape, to defining tasks. The experience of confrontation has made it possible to evaluate the digital innovative processes that back up the financial system of the future, and to identify their need for support. At the same time, it has also become clear that incumbent banks, constituting a key factor of the financial intermediary system, must be protected from the damage that might be caused by new digital actors in the market. The task is therefore twofold and complex: the sustainable financing of competitiveness and economy requires the creation of a set of operating conditions that is supportive and permissive where it is necessary and, at the same time, provides strict control, monitoring and restrictions where risks and systemic problems occur. In solving this twofold task, we must find a delicate balance that reduces the potential for regulatory arbitrage and regulatory asymmetry, i.e. we must ensure a level playing field. Having inspected the sometimes complex labyrinth, we can conclude that neither the

European Union nor the Hungarian practice is on the wrong track, although the condition of "same activity, same regulation" has not yet been met. Nevertheless, in the first year of this decade, work towards a solution has been launched, however, the COVID-19 pandemic has had a twofold impact on this simultaneously: in some areas, it has accelerated the development, while in others, it has resulted in a – hopefully temporary – slowdown.

This is the only way to realise a level playing field, which has not yet been achieved. Developments have already taken place in various areas, even through international cooperation, but these have mainly regulated the ethical requirements and standards of conduct of FinTech.

These initiatives have been important in themselves, but one of their key added values is to explore the functioning and potential risks of areas in need of regulation, and thus to provide guidance for the development of a comprehensive regulation. Proceeding along this path, a number of regulatory initiatives have been launched and are under way, several of which we have presented, along with the difficulties and simultaneous urgency of the task, as it is nothing less than the stability of the financial system and the prevention of risks to it that is at stake.

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The Work of Milgrom and Wilson in the Theory and Practical Application of Auctions*

Péter Biró – Gyula Magyarkuti

This paper seeks to provide insight into the field of auction theory to the general readership, the area of the 2020 Nobel laureates in Economic Sciences, Paul Milgrom and Robert Wilson. To understand for what reasons and for what purpose they were awarded the Nobel Prize, it is worth taking a step back, looking at this area of economics from a greater distance. For this reason, we not only report the results associated specifically with their names here, but we also review the path to get here. Finally, we provide an outlook for the future of the topic with a brief description of the interdisciplinary areas of engineering economics and market design.

Journal of Economic Literature (JEL) codes: C78, D44, D47

Keywords: auction, game theory, mechanism design, market design, engineering economics

1. Outlook

Milgrom and Wilson received the 2020 Nobel Prize in Economics for advancing the theory of auctions and developing new auction procedures. Wilson was the doctoral advisor for Milgrom's PhD at Stanford, and Milgrom is now Wilson's third Nobel Prize-winning student after Roth (2012) and Holmström (2016). This recognition has long been expected by the profession, and Milgrom's work, with more than 100,000 references, is outstanding among theoretical economists.

Numerous summaries and laudatory articles have been published on the work of the two laureates in recent months. One of the aims of our summary is to present the work of the winners and the topic of auctions to Hungarian readers. Another one is to provide a mathematically founded introduction to auction theory in addition to the summary in the official scientific background report, and to analyse

* 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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in more detail the new interdisciplinary fields of engineering economics and market design that include auctions.

We encounter auctions in situations where neither the seller nor the buyer knows at what price it would be worthwhile to conclude a transaction. Of course, both the seller and the buyer can imagine an amount which is small enough or large enough that they think will already make an adequate profit, but it is rather questionable whether the demand and supply generated in this way will meet. In such a situation, organising an auction can be a way out.

The naturalness of this idea is also reflected by the fact that we can find very ancient examples of it in human culture. Here are just three examples that are at least 2,000 years old. One of the oldest references in the literature mentions the Greek historian Herodotus: *Krishna* (*2002*) gives a detailed description of the way in which an assignment for marriage between women and men was created in ancient Babylon. In the Bible, according to Matthew 27:35: "And they crucified him, and parted his garments, casting lots..." In our interpretation, the term "casting lots" here does not imply a query of God's will, but rather the appearance of an auction—in addition a multi-object one—on the specific course of which we do not receive information here. Our third example also relates to the Roman Empire. There is written record that the Roman Empire's state administration routinely used auctions. Shubik (2004) notes that in one case of Cicero, in 80 BC, his client's property, which the client offered as a guarantee in another transaction, had to be auctioned. At the time, it was customary to confiscate debtors' property and then auction it off. Sulla extended this even to the assets of his political opponents, thus liquidating his opposition and at the same time generating huge revenue for the treasury. Ovid records in 10 AD that it is worth releasing the state from the burden of collecting taxes by auctioning the right to collect them. To give an overview of ancient auctions is far from the purpose of this essay. For readers interested in the topic, we recommend the very interesting work by *Shubik* (*2004*) Section 8.1.2. According to Nobel Prize Committee (2020), the oldest auction house still operating today is the Stockholms Auktionswerk, founded in 1674.1 Sotheby's in London or Christie's in New York, known to almost everyone, are the two largest art auction houses. For many people, the concept of today's auction is confused with Sotheby's or Christie's fine art treasure auctions, which is incorrect and misleading. The volume of fine art treasure auctions accounts only for a negligible share of the volume of all auctions. In general, it may be said that auctions have never been as important a slice of economic activity as they are today. Fish, fresh flowers and diamonds are traditionally marketed through auctions. Similarly, a bond issue is a special auction, and from mining rights to the auction of mobile phone frequencies

[1] By clicking on the link http://auktionsverket.com/, you can immediately bid on something or even sell something.

all are examples where conducting an auction guarantees a deal, i.e. an auction is used to select the winner and determine the price of the product. In the 21st century, the concept of online auctions has become quite important. A huge amount of things are sold and bought on the eBay platform, for example. Considerable EU grants are also auctioned. For example, the state aid for the establishment of solar farms, among renewable energy subsidies, in Germany has been distributed via multi-object auctions for years. The products are subsidies given to individual producers, and the bids are the estimated costs of the applicants. Of course, this is a reverse auction in the sense that, for example, the aid for 20 products, i.e. 20 solar farms, will be won by the first 20 lowest bidders in the order. For details, *see Kácsor* (*2021*).

The latter example also shows that the concept of auctions is worth considering in a rather abstract way and that applications may emerge that at first seem quite distant from the layman's concept of auctions. Just for the sake of provocation: a simple lottery game is also an auction. The role of bids is played by the number of lottery tickets purchased, and the winner of the auction is the one whose ticket is drawn. More importantly and interestingly, the order of the ads built into Google's search engine is determined by the results of a multi-object auction running in real time when searching (*Edelman et al. 2007*). We write about this in more detail later.

2. Auction Theory

The question arises as to what we mean by auction theory. The answer can be summarised in the following two questions.

– How do bidders behave in the case of different auction formats under different auction conditions?

– How can the auctioneer choose the auction format and playing rules that best suit its goals?

To approach the first question, we need to understand what forms of play may arise, and for the second question, we need to see that the purpose of the auctioneer can be quite varied. It is possible that it wants to maximise its profits, but it is also possible that the goal is to achieve optimal social well-being.

As compared to physics or engineering for example, one generally accepted disadvantage of economic theories is the lack of experiments. Just think of macroeconomic problems, the theory of money, or equilibrium theory. Many times we feel that abstractions and results that are beautiful in themselves would be complete if some experimental realisation of them could be provided. By contrast, it is common experience that we can come to conclusions about the operation of

the economy that are contrary to the theoretical results. In our view, auction theory plays a rather prominent role in this matter. Every single auction actually played out is, after all, an experiment of theory. In this way, the much-desired verification becomes possible. Furthermore, in addition to observing real markets, the use of laboratory experiments with human decision-makers in the field of experimental economics has intensified in recent decades, proving to be particularly useful in auctions, see for example (*Kagel et al. 2010*).

In this regard, it is also worth thinking about the work of the Nobel laureates honoured here. The radio-spectrum auction (CCA) they constructed was used in the UK in 2008, and then the frequency rights of Austria, Australia, Denmark, the Netherlands, Ireland, Canada, Romania, Slovakia and Switzerland were sold using essentially the same technique (see *Nobel Prize Committee 2020*). Of course, for the governments of the countries in question, the goals of the spectrum sales are the most important, but as a by-product, the theory created by the Nobel laureates has also gained practical verification, providing an example for the practical application of rigorous scientific theories.

Paul Milgrom is 73 years old, Robert Wilson is 84. It is clear from their ages that their recognition is the recognition of their entire scientific career, but not only that. The decision of the Nobel Prize Committee is seen by the profession as the setting of direction for further development as well. Of course, the relevance of this is debatable, but if we look back at the Nobel Prizes in economics of the last century, this idea is strongly confirmed. In their case, the question then also arises as to what the message of their Nobel Prize is to the scientific community. In our view, the answer is very simple and clear: shifting economics towards engineering. Think about what the state does when it wants to build a major public bridge. A firm of architects is commissioned and the expectations regarding the bridge is communicated to them. The engineers in the architecture office then work out a state-of-the art plan and even a construction plan that ultimately defines the construction process down to the smallest screw. Accordingly, the idea that, in an imagined brave new world, if the state needs spectrum auctions in the public interest, for example, it should be able to turn to a community whose members are able to define the best form of auction based on scientific principles, and not only define it, but design it down to the finest details.

2.1. The simplest standard auctions

To approach the results of Milgrom and Wilson, it is worth starting with the simplest auctions. We speak of a *standard auction* if the highest bid wins, i.e. the player with the highest bid receives the object of the auction. Examples of non-standard auctions are any auctions that use a reservation price or a lottery game. The simplest and also the most popular standard (single object) auctions are:

Dutch or clock auction:

The announcement starts at such a high price at which it is not worth obtaining the object of the bid for any of the bidders. The price is gradually reduced in small increments until it becomes just right for one of them. The bidder indicates this, for example, by a show of hands. This ends the auction, and the winner of the auction, i.e. whoever obtains the item, is the player with the raised hand, who has to pay the price that was valid when the game ended.

Using this method, more than 20 million flowers are marketed in the Netherlands every day, which is why it is called the Dutch auction. Federal Reserve bonds are also issued using a similar auction (see *Nobel Prize Committee 2020:7*). In connection with bond issues, we also recommend *Monostori's* (*2013*) review.

English auction:

In contrast to the previous one, the auction starts at such a low price that many bidders would buy the object of the auction at that price. The price increases gradually, in small enough steps. If the price becomes so high that it is no longer acceptable to a player, the player in question will withdraw from the auction. They indicate this by lowering their hand, for example. The auction ends when there is only one bidder left in the game. The winner of the auction is the only bidder, and it will have to pay the going price at the end of the auction.

The root of the word "auction" may come from the Latin verb "augere" (increase) suggesting that the English auction may have been known in the Roman Empire as well. Art auctions, also known from films, such as the auctions of the Sotheby's auction house, also work in this manner. This is why it is called an English auction.

First-price sealed-bid auction:

Bidders place their bids in a sealed envelope, which means that the players in the game have no information about each other's bids. And with that, the auction ends. After the opening of the bids, the bidder making the highest bid is the winner of the auction, so it will obtain the object and has to pay the amount of its bid.

Second-price sealed-bid or Vickrey auction:

This form is identical in all respects with the first-price sealed-bid auction, except for the obligation to pay. The winner of the second-price sealed-bid auction is not obliged to pay its own bid, but the highest losing bid, i.e. the second highest of all bids.

It is a textbook case that the dominant equilibrium strategy of this auction is truth-telling, i.e. rational bidders in this auction bid with their own valuation.

Let us examine the above four auctions based on the following criteria:

1. Who wins?

2. Who pays what?

In the above auctions, the object is won by the player with the highest bid placed in one way or another, and they are always the only one to pay. Losing bidders pay nothing. The obligation to pay is the value of the highest bid submitted in one way or another in the case of the Dutch and the sealed-bid first-price auctions, while it is the value of the second highest bid arriving in one way or another in the case of the English and the second-price auctions.

Therefore we see that, from this point of view, the Dutch and the sealed-bid first-price auctions belong together, and similarly, the English and the second-price auctions are related. The question is whether we can consider the Dutch auction to be exactly the same as the closed-bid first-price auction, and by analogy that the English auction is the same as the closed-bid second-price auction.

2.2. Information content of evaluations

We assume that the players are rational, they have some evaluation of the object of the auction, and their bid is based on that evaluation. How the valuation can take shape is well illustrated by the information gap between the English auction and the second-price auction. In the English auction, the exiting players will gradually announce their bids. In the end, only the exact value of the winning player's bid remains a secret. Of course, no information will be revealed during the process of the second-price sealed-bid auction.

If we compare the Dutch auction with the first-price, sealed-bid auction, we find a difference in information there as well, but this difference is not as severe as in the case above. During the process, everyone has at least an upper estimate of the other players' bids, but that is the entire difference. When the Dutch auction ends, the exact bid of the winner is revealed, but this is too late for the other players as the auction is just coming to an end.

The question is whether or not this information difference is incorporated into each player's valuation. Based on this, we differentiate the valuations:

1. Private values:

When the participants, regardless of the influence of others, know how much the product is worth to them. By this we mean that none of the players knows – and moreover they are not even interested in – the other players' evaluation of the object of the auction.

This typically occurs when the usefulness of the auctioned item comes solely from the consumption of the item. Our initial impression is that there may be very few such auctions. Art auctions or bond issues, for example, are very far from this, as the usefulness of an object is also influenced by the secondary market, and thus the present value depends on the future valuation of others.

Note that in practice, a really relevant case may be included here. For example, the most important factor in the evaluation of support for solar farms for a landowner is the number of hours of sunshine on their land. This valuation is not affected in any manner by the valuation of the owner of another farm which may be hundreds of kilometres away.

It is also worth seeing that the auction of spectrum frequencies is similar to this, and yet it is not. Obviously, there is a private valuation aspect, since, for example, the necessary technological tools are available to everyone in much the same way and market demand can be estimated in an exact way, but the value of each frequency band depends very much on the frequencies of neighbouring areas and thus on the possible outcomes of other auctions. In addition, bidding companies may have a different range of service-providers and business strategies, so a spectrum package may have different utilisation values for them.

2. Common values:

When it is not about a private value auction. This is the case where the evaluation depends not only on the item auctioned itself, but also on the opinion of the other participants about it. Typically, this is the case of an assessment where the value of the item depends on a value that develops in a possible secondary market. The evaluation of oil fields, for example, is certainly like this. It is impossible to know the exact capacity of an oil field, and estimating it is also very expensive. In this way, all of the information obtained about the capacity is extremely valuable, and thus by expressing their valuations, the parties involved in the game influence each other.

We can say that under the assumption of private values, the first-price sealed-bid auction can be identified with the Dutch auction, and similarly, we also make no distinction between the second-price sealed-bid auction and the English auction. This is called *strategic equivalence*, by which we roughly mean that if the same players played the two types of auction with the same values, the winner's identity and the auctioneer's revenue would be the same in both auctions.

2.3. Private values

The revenue equivalence principle is the basis of the theory of private value auctions. Auction theory research in recent years has been motivated by the violation of this. The point of the idea is that assuming strictly private valuations, under sufficiently broad conditions, the payment of players does not depend on the

specific construction of the auction; for details, see *Krishna* (*2002*) or *Magyarkuti* (*2018*) in Hungarian.

Theorem (revenue equivalence principle): Suppose that a standard auction conducted in a symmetric model with private values is played by risk-neutral parties with a strictly monotone increasing bidding function in a symmetric Nash equilibrium situation.

At this point, each player's expected payment function is independent of the structure of the auction and can be written independently of the Nash equilibrium bidding function used.

Thus, the auctioneer's expected revenue does not depend on the bidding functions that guarantee Nash equilibrium, nor does it depend on the structure of the auction.

Each player knows their own evaluation, but for the outside observer, the players' evaluations are the realisation of a random variable. Let these be $X_1,\ldots, X_N$ with the same *F* distribution. The assumption of private values implies the independence of these random variables. We assume that all players use the same β Nash equilibrium bidding function. Since the betting function gives a one-to-one correspondence between possible bids and evaluations, the player with the highest evaluation wins, so the probability of winning with evaluation x is $G(x) = F^{N-1}(x)$. Similarly, since everyone uses the same bidding function, the expected payment of each player depends only on their valuations. We denote this by $m(x)$. Then the equilibrium profit is $G(x_0)x_0 - m(x_0)$ with a given x_0 valuation and the corresponding $b_0 = \beta(x_0)$ equilibrium bid. But if our player indicated bid b, with the others still using the β bidding function, then its expected profit would change to $G(\beta^{-1}(b))x_0 - m(\beta^{-1}(b))$. According to the concept of the Nash equilibrium, this means that with a given x_0 evaluation the function:

$$b \longmapsto G(\beta^{-1}(b))x_0 - m(\beta^{-1}(b))$$

at point $b_0 = \beta(x_0)$ is at a maximum, and thus its derivative is zero here. Let us denote the derivative function of *G* by *g*, and accordingly the derivative of the above factorised right side will be: $g(\beta^{-1}(b))\frac{1}{\beta'(\beta^{-1}(b))}x_0 - m'(\beta^{-1}(b))\frac{1}{\beta'(\beta^{-1}(b))}$. The value of this at $\beta(x_0)$ will be zero, ergo $m'(x_0) = g(x_0)x_0$. Of course, this is true for every evaluation, so according to the fundamental theorem of calculus, for every possible x evaluation

$$m(x) = \int_0^x g(x_0)x_0 dx_0\,,$$

assuming that we allow that with zero evaluation the player has no cost, that is $m(0) = 0$. And we are ready, since m depends only on g which is given by the distribution of the random variables describing the valuations. The expected payment m therefore does not depend on anything else. Of course the expected

revenue of the auctioneer is $\sum_{j=1}^{N} E\left(m(X_j)\right)$, since the entire revenue of the auction comes from the bidders. We have thus obtained that the expected revenue for each such auction is the same amount, regardless of the specific structure of the auction.

Specifically, first-price, second-price, everyone-pays or only-losers-pay auctions in such circumstances result in the same expected revenue for the bidder.

Without getting lost in details, the most important assumption of the above train of thought is the independence of the random variables describing the valuations, that is, the assuming of private values. The event $(X_2 < x) \cap (X_3 < x) \cap \ldots \cap (X_N < x)$ means, for example, that the evaluation of the first player is the highest. The reason why the probability of this event is $F^{N-1}(x)$ is independence, so $G(x)$ is the probability of winning of a player with evaluation x in a standard auction. There are much more general known versions of the revenue equivalence principle explained above, also for multi-object auctions for example, but the point is the assumption of private values.

One important consequence of the revenue equivalence principle is that it makes it possible to describe the behaviour of bidders under different forms of auction. For example, in a first price auction, $m(x) = G(x)\beta(x)$, since the expected payment is the probability of winning multiplied by the payment obligation in the case of winning, which is the current bid in a first-price auction. Here, as before, the Nash equilibrium bidding function is β. From this and the above, the Nash equilibrium bidding function of the first-price auction is immediately derived:

$$\beta(x) = \frac{1}{G(x)} \int_0^x g(x_0) x_0 \, dx_0 .$$

Without going into the mathematical details here, the Nash equilibrium bidding function of an arbitrarily structured auction arises similarly. It is worth noting that in a second-price auction rational players use the identity (truthfulness) bidding function; in the first-price auction the above highlighted bidding function always results in a lower bid than the evaluation, but in a third-price auction we get higher bids than the evaluation.

2.3.1. War of attrition

Here we would like to draw attention to the fact that understanding the behaviour of the parties participating in auctions can lead to interesting results even in areas far from economy. To illustrate this, a nice example is the analysis of the war of attrition auction in Milgrom's book (*Milgrom 2004*) – considered a fundamental work. The definition of the simplest case is as follows: We only have two players, the winner is the player with the higher bid. The winner takes the object of the auction and both players pay the losing, i.e. the smaller bid. At first glance, we may feel that this auction is exotic, but then we may notice that mankind plays out such

auctions in varied and very unfortunate situations, so the conclusion may be that such situations should be certainly avoided.

Milgrom's interpretation is as follows. Two hungry beasts are facing each other. What they are bidding with is the work invested to get the food in front of them. By this we can mean the loss of energy caused by the fight, or the (negative) usefulness of the injuries caused by the fight, or simply the amount of time spent getting the food, i.e. the length of the fight. Clearly, the loot is taken by the one who gives up later, but they both pay for their investment in the battle. So, the war of attrition auction really models the conflict.

Following the previously introduced formalism, using the revenue equivalence principle, we obtain that the Nash equilibrium bidding function looks like this:

$$\beta(x) = \int_0^x \frac{g(x_0)x_0}{1 - G(x_0)} dx_0.$$

Considering that with high x_0 evaluations the denominator tends to zero, so it appears that the Nash equilibrium bidding function of the war of attrition auction tends to infinity for a sufficiently wide range of distributions when the evaluations tend to the highest possible value. We see then that the rationality of the parties in the war of attrition auction – since this is a matter of Nash equilibrium – is, unfortunately, that irrationally high bids are placed. Hence, the conclusion that these conflicts should be avoided. An unfortunate historical example of the failure to avoid a war of attrition auction situation is the Maginot Line built after World War I or the Battle of Stalingrad in World War II.

2.4. Common values

As noted earlier, we speak of common values when bidders do not formulate their evaluation independently. The first phenomenon we need to understand is the so-called winner's curse.

Consider the following thought experiment: We auction an object of roughly equal value to players who pay close attention to each other and base their evaluation not only on the usefulness of consuming the object, but also place great emphasis on incorporating information from the evaluation of others into the value of the object. Of course, none of the bidders can pinpoint the exact value of the item, they only estimate it. We can express this by assuming that each player puts a white noise from, for example, the normal distribution on their own original evaluation. This will be their estimate, and then the evaluation of neighbouring players will be based also on this. But not only on this, also on their own evaluations, independent of the others, on which they also put their own white noise, and so on, for every participant in the auction. Under such circumstances, if the ownership

of the object really gives everyone a similar utility, then the average of the values may be the closest approximation of the true value. This means that in a standard auction, it is definitely bad news for the winner that he won, as he is the one who deviated the most from the average, i.e. he closes a first-price auction probably with a negative profit. We also see that as the number of players in the auction increases, overvaluation becomes more severe. This is called the winner's curse. It is very important to emphasise that we never talk about a winner's curse in the case of private value auctions, as there the other bidders have no influence on the current valuation.

The winner will therefore certainly overestimate the value of the item. Players, on the other hand, think rationally, which specifically means that they are able to understand the above idea, so another twist is added to the story. So they know that the winner who comes out of them overestimates the object. Therefore, they strive to avoid the resulting overvaluation, so that this fact is also built back into the formulation of their valuation. The consequence of this may be that the auctioneer will not receive the true value of the object.

Milgrom and Weber (*1982*) analysed the revenue of the four simplest auctions with common values. They came to the result that under the same circumstances the highest average revenue comes from the English auction, less comes from the second-price sealed-bid auction, and, finally, the Dutch and the first-price auctions yield the third highest revenue. In this regard, we note that the strategic equivalence between the Dutch auction and the first-price sealed-bid auction still exists. It can be seen that the highest valuation only becomes known when the Dutch auction is about to end, so the parties to the auction cannot use this additional information.

Looking ahead to the FCC auctions to be detailed later, we can conclude that the loss of revenue caused by the winner's curse can be mitigated by sharing as much relevant information as possible with the bidders. This is the so-called linkage principle. The idea is that the reason why in English auction players can filter out disturbing effects more efficiently also from their common values is because they gain more and more information as individual players reveal their evaluations. Later, this idea will be seen echoed in the famous frequency auctions where a slower, preferably multi-round auction format is used, which forces the players to reveal their real evaluations, with the result that the winner's curse effect is reduced.

3. Multi-object auctions and related applications

So far we have investigated single-object auctions. In real markets, however, auction procedures are becoming more common even in more complex cases where a buyer wants to buy a larger quantity of a product or several connected products at the same time. In this chapter, we introduce this topic.

3.1. Divisible objects

If one or more sellers want to sell a large quantity of a homogeneous product to several buyers at the same time, we speak of a so-called share auction. The earliest application for this is the market for claims or public debts, but energy markets (*Wilson 2002*), or, say, the market for fishing rights (*Bichler et al. 2019*) can also be mentioned and linked to the work of the Nobel laureates as well.

In Wilson's pioneering article (*Wilson 1979*), he examined a model where customers could also give their valuations for certain parts of a divisible object. He examined two types of auctions. In one case, the common price is a condition, while in the other, the customers are allowed to pay different prices for the same quantity of products according to their offers. It was shown that, compared to single-object markets, market participants have even more incentives to bid lower than their actual valuation and are even more able to push down equilibrium prices through coordination. In Hungary, for auctioning government securities, the replacement of discriminatory pricing by uniform pricing was raised following the Polish example (*Monostori 2013*). In a later study (*Wilson 2002*), Wilson discussed modelling problems related to the energy market in detail, on some of which he presented theoretical results later (*Wilson 2008*).

3.2. Multi-object one-to-one auctions

In this section, we briefly discuss the special case where customers can bid on more than one object at a time, but each buyer wants to buy only one of the several options. Then the problem still remains tractable, and we give an example of this in connection with the auction of online advertising space.

The job market is a simple but important example for this type of market, where employers typically advertise one job and employees look for one. For the game-theoretic description of this market, the assignment game (*Koopmans – Beckmann 1957; Shapley – Shubik 1971*) is the best suited one, where players can form pairs and share the benefits among themselves. A stable (or core) solution always exists, and among the stable solutions there are two extreme ones that give the best solution to all the actors on one side or the market or the other. If an auction provides, say, an optimal solution for buyers, then the mechanism cannot be manipulated by buyers, i.e. everyone's best strategy is to give their true valuation as a bid.

The assignment game is a good approximation for the labour markets (*Fox 2018*), but auction solutions are not used here at all due to the decentralized nature of the market. In the case of the sale of online advertising space, however, the task is similar, and algorithmic auctions are widespread there. A significant example of this is presented below.

3.2.1. The keyword auction of Google

Billions of searches are done on Google every day, and each time there is an algorithmic auction running in the background that determines which buyers' ads will appear as paid ads in the possible 4–5 places on the user's page. 90–95 per cent of Google's revenue comes from these types of keyword auctions, which means that huge amounts of money are involved. One of the great benefits of online advertising is that it is personalised, as the service providers (Google, Facebook, etc.) can have important information about the user who is searching or browsing and can therefore sell the ads in a personalised way at the user interface. The other technological advantage is that the result of the advertisement can also be measured well with the help of cookies, and thus the billing towards the advertising companies is more accurate. You can pay for an impression, for a click, or for a completed transaction. Google uses the pay-for-click version to auction keywords.

Considering the nature of the auction, the assumption that each buyer wants to buy at most only one advertising part on the site is fulfilled, so in theory the buyer-optimal solution of the assignment game can be applied, which has actually been analysed (*Aggarwal et al. 2009; Dütting et al. 2013*). In contrast, the solution used by Google has been a simpler general second-price mechanism (*Edelman et al. 2007*). The bottom line is that the best, first, ad slot is given to the buyer who bids the most, but they only have to pay the second bid. The second buyer pays the third bid, and so on. More specifically, they look not only the bids, but also the relevance of the ad for that particular keyword and user, a metric of which is multiplied by the buyer's bid, thus forming a ranking of the buyers. The price paid by the winning customers means a price sufficient to maintain the ranking.

This auction is not strategy-proof because it is possible to give an example when a buyer has to pay significantly less, say, for the 3rd place than for the 2nd one, even though it is not worth much less to them (see for example in the *Haeringer 2018* textbook). However, the current design has a number of advantages. For example, it encourages companies to advertise relevant content, making customers more satisfied, and generating more revenue for Google especially because they receive the payments for clicks. It should also be said that ads are typically ordered by companies in complex campaigns rather than individually, meaning that the small strategic profits at each auction are negligible compared to the fact that the companies can run a well-organised, and measurably efficient campaign with predictable costs on Google's platform.

3.3. Indivisible, interrelated products

If a buyer can buy more than one product for which there are complements in their valuation, the auction problem becomes much more complex. For this case, we first present VCG auctions, which have good theoretical properties, but there

may be several problems in their practical application. One of Milgrom and Wilson's most important practical works is the FCC's 1994 spectrum allocation auction (*Bichler – Goeree 2017*), which is based on a simultaneous multiple round auction (SMRA, or simultaneous ascending auction, SAA). An improved version of this is the combinatorial clock auction (CCA), where buyers can also bid on packages. We conclude the chapter with an introduction to the so-called Incentive Auction, first used in the 2017 FCC auctions, where the frequencies of radio and TV operators were first bought centrally and then, after re-allocating the remaining frequencies, the freed bands were sold to mobile operators.

Now, what is the challenge in multi-object auctions? Take a simple case that the Nobel laureates also mentioned in their lectures. Suppose the spectrum is auctioned simultaneously in Northern and Southern California. There may be a company that is only interested in buying a frequency in the South, but there may also be another that wants coverage for the entire state for its service and therefore a license for only one region is worthless for them. If spectrum auctions are announced for the entire USA, those interested in much more complex packages will also appear.

An allocation is said to be efficient if the combined valuation of the customers is maximal. This is a basic requirement for the solution, but the revenue received by the seller is also an important consideration especially when it comes to government revenues, so it also plays a role in pricing. However, the mechanism should continue to encourage buyers to disclose their true valuations, ideally in a strategy-proof way, but approximately real or well-estimated bids may also be satisfactory when evaluating the auction results. Finally, an important aspect is the simplicity of the mechanism. In many cases, it is impossible to request the full value function of customers, as they would potentially have to provide it for an exponentially increasing number of packages in the number of products. One possible treatment for this issue is to pre-select relevant packages, or use iterative procedures where customers only give bids for packages that are realistically available to them.

What are the possible problems and solutions? Consider the following simple example: There is an apartment and a garage that the owner wants to sell in an auction, either together or separately. Three interested parties arrive, buyer *A* is only interested in the apartment, he would give 43 million forints for it, buyer *B* only interested in the garage, and he would buy it for a maximum of 12 million, and buyer *C* would buy the two for 50 million, but only together. The efficient allocation in this case is when buyer *A* gets the apartment and buyer *B* the garage. But how can an auction achieve this efficient result, and most importantly, how much should the buyers pay?

3.3.1. VCG auctions

The Vickrey-Clarke-Groves (VCG) auction is based on three classic papers: *Vickrey* (*1961*), *Clarke* (*1971*) and *Groves* (*1973*). Among them, Vickrey's work was also recognised with a Nobel Prize in 1996. In the case of a multi-object auction, it works as follows: Each buyer can bid on any package of objects. The allocation of the solution will be efficient for the bids as well as for the valuations, as it can be seen that the mechanism individually incentivises each customer to tell the truth. The price is defined as follows: each customer pays as much for their package as much the overall utility of the other customers is reduced by removing that package from the product set.

In the previous example, buyer *A* will pay 38 million, as the two objects are worth a maximum of 50 million to the other buyers (this is the case if both objects are received by buyer *C*), while without the apartment, the remaining set of objects (which is merely the garage) is worth 12 million for buyer *B*, so the difference between the two will be the price for buyer *A*, that is, 38 million. Similarly, it can be calculated that buyer *B* will have to pay 7 million for the garage. The total revenue of the seller is therefore 45 million.

The VCG auction operates also in a much more general framework than multi-item markets, and its main feature is that the best individual strategy for each buyer is to provide true valuations. It follows that solution allocation is always efficient for true valuations. In practice, however, VCG auctions are not used in many applications, for several reasons. On the one hand, it can generate low revenue for sellers. In the example above, if customer *C* leaves, then both *A* and *B* will receive the evaluated item for free. This problem can be partially avoided with minimum prices. The other problem is that the buyers can cooperate and get a better price. In the example, if *C* reduces his bid, the other two buyers will be better off because they have to pay less and may be able to share that benefit with each other afterwards. In larger markets, even the calculation of efficient allocation can be difficult, as this is an NP-hard problem for complementary products, i.e. no fast algorithm is expected to compute the solutions. This is a considerable problem also because the use of approximate solutions can be not only suboptimal for the final allocation, but it can make also pricing very inaccurate.

However, there are applications such as one-to-one auctions and their minimal generalisations for which VCG still works well. One famous example of this is the auction of Facebook advertising space (*Varian – Harris 2014*). In the more complex markets, as an alternative to VCG, simultaneously-ascending-price auctions based on a relatively simple principle appeared in more and more applications in the 1990s. One of the most significant of these was the spectrum market which is described in the next section.

3.3.2. Spectrum auctions

Licenses to use the radio frequency spectrum have previously been allocated among applicant companies by government decision or simple lottery. From the 1980s onwards, the use of auctions became more widespread. On the one hand, national governments recognised that they could generate high revenues from this. On the other hand, market price competition, if used properly, also ensured that companies that could generate the greatest social and economic benefits from this finite resource received the rights. Designing spectrum auctions has become a priority task for auction theorists, resulting in extensive research and successful applications (*Bichler – Goeree 2017*).

The US Federal Communication Commission (FCC) is responsible for regulating the US radio frequency market. In 1994, as proposed by Milgrom, Wilson, and McAfee, it was implemented through an ascending-price simultaneous auction (SMRA), which generated even more revenue than expected and then it spread to many countries around the world (*Bichler – Goeree 2017*). The essence of the procedure, which was analysed in detail by *Milgrom* (*2000*), is that bids can be received in several rounds, iteratively, and after the last active round, each item is given to the buyer who offered the most, and the price equals the final bid.

In the example above, all three buyers would certainly actively raise their bids until the combined price of the apartment and garage reaches 50 million forints, say, at 40 million for the apartment and 10 million for the garage, where buyer *C* exits the auction. We can see that we get the same efficient allocation, but the seller's revenue here will be higher than in the VCG auction.

What are the advantages and possible disadvantages of the method? It is definitely simpler and more transparent than VCG; the buyers only have to make an offer in response to the given prices, so they do not have to give the valuations on all the possible packages, the prices contain all the relevant information. It is expected to generate more revenue for the seller than VCG. Finally, under certain conditions, the final allocation remains efficient, for example, in the absence of complements, in the case of substitute products, assuming straightforward bids from the customers (*Milgrom 2000*).

Among its disadvantages, manipulation by demand reduction and the exposure problem can be pointed out, which are presented in more detail below.

The exposure problem can be illustrated in our example as follows. Let us suppose that players *A* and *B* are now the same first player, so he would either buy just the apartment for 43 million forints or just the garage for 12 million, but he does not want to buy both. Player *C* does not change, he will be the second player. In this case, following their real valuations, the prices start to rise again, the first

(*A* + *B*) player always bids on only one item, and for the second (*C*) player it is worth matching the bids until the combined price reaches HUF 50 million. When, on the other hand, it reaches that, e.g. at a price of 40 million and 10 million, he faces the following problem: he is leading with his bid only on one item, and this single item is worthless for him in itself, i.e. if the auction stops, he will realise a big loss. Therefore, he will be forced to continue bidding, to reduce his loss, even if the total price already goes over 50 million forints. Buyers who prefer larger packages are therefore exposed to the fact that, in the end, they may not get full, valuable packages or may have to pay more than their real valuation to obtain them, and thus suffer a loss.

Regarding demand reduction, let us imagine that in addition to the previous first (*A* + *B*) player, for the second player (*C*) now, in addition to the 50 million apartment + garage pair, the apartment alone is also worth 38 million. This, truthfully following the real valuations in bidding, leads to the result that the first player buys the garage for 12 million, while the second player buys the apartment for 38 million, so neither of them realises a profit. If, on the other hand, the second player gives up the apartment and garage pair and does not bid on the garage at all, the garage will go to the first player for a minimum price of 1 million, and in return the second player will not go over 32 million for the apartment, since his gain would not be higher than in the case of the garage (12 – 1 million). That is, by reducing his demand, the second player achieved that the first player was satisfied with the garage, so he was able to get the apartment at a better price, and both of them were better off by this manipulation.

A third problem with ascending auctions is that there may be a buyer who waits till the very end, and then, in the last round, knowing the prices, takes the packages that are most favourable to him, leaving the others high and dry; this action is called sniping.

How can these problems be prevented in practice? The exposure problem is most severe when there are significant complementarities between products, and the value of a product package is much higher for customers than the sum of their sub-values. This issue can be avoided by a combinatorial auction, a version of which is the combinatorial clock auction developed by Milgrom and others (*Ausubel and Milgrom 2002*). For some applications, the pre-selecting of packages may also be a solution, such as selling valuable bands to one of the mobile operators instead of certain frequencies. The other two problems can be partially remedied by regulating the customers' possible bids according to certain activity rules. It is worth it therefore for the bidders making their initial bids in a similar way to their final bids, so that intermediate prices cannot mislead the other bidders. This was an innovation by Milgrom, which was already used in the 1994 procedure and later became common practice everywhere.

Led by Milgrom, the FCC's 2017 spectrum auction was designed to respond to a special situation. Most of the earlier licensees of radio frequencies operated TV channels, but it became much more profitable to use the frequencies for mobile services. The task of the designers was to sell the frequencies purchased from the TV channel operators to the mobile operators. The procedure was proposed by Milgrom and others (*Milgrom et al. 2012*), and then the 2017 implementation was also done under their leadership (*Milgrom – Segal 2017*).

The essence of the procedure was that first a price was set in a reverse auction at which most TV operators were willing to sell their licenses. In parallel, the frequencies sold were auctioned to mobile operators in a forward auction in such a way as to generate an additional profit for the government from the price difference. However, it was also important to have the technological possibility to alter the bands of the service providers that retained their licenses, thus allowing the released frequencies to be provided in bands close to each other and with large area coverage to adequately meet the needs of the new mobile operators. This re-tuning led to an NP-hard graph colouring problem, where computer scientists also helped the organisers to efficiently solve the problem (*Newman et al. 2017*). The process was successful, with the state taking back licences amounting to about 10 billion US dollars from TV channels and selling them to mobile operators for about 20 billion. State intervention has, on the one hand, generated significant revenue and, on the other hand, successfully resolved the exchange of usage rights, which put the resources in the hands of the companies that utilise them most efficiently.

3.4. Additional allocation applications

As already mentioned, one area related to auctions is the organisation of matching mechanisms, where the difference is that payments are not allowed between participants. The basic matching algorithm for the university admission procedure was developed by *Gale and Shapley* (*1962*) in 1962. The admission system for secondary and higher education in Hungary is also based on this mechanism. Fifty years after the publication of this article, Roth and Shapley also received the Nobel Prize for their theoretical research in this field and for their participation in practical applications (*Biró et al. 2013*). The area of matching and auction mechanisms is covered together by the topic of market design. This is already taught in university courses as a separate field, for example by Milgrom at Stanford; we recommend the textbook on the subject by *Haeringer* (*2018*) to readers.

The fields of auctions and matchings are closely related. There are also models that can be said to be a common generalisation, such as the matching with contract model analysed by *Hatfield and Milgrom* (*2005*). In this, the parties to the pair can agree not only on the payment of money, but on any kind of contract. Under certain conditions, there always exist fair (also known as stable) solutions, and they form

a lattice with two extreme solutions that are considered the best for all sellers and all buyers, respectively.

These results were already proven by *Fleiner* (*2003*) in an earlier paper on an even more general model, but *Hatfield and Milgrom* (*2005*) also showed that in the buyer-optimal solution, it is not worth manipulating the procedure individually by the buyers if certain monotonicity conditions are met. This result implies, among other things, the strategy-proofness of second-price auctions even for multi-object models, applicable for example also to keyword auctions conducted by Google (*Aggarwal et al. 2009; Dütting et al. 2013*).

In the following, we present two allocation applications where there is basically no payment, but with the introduction of tokens, essentially an artificial combinatorial auction procedure has been introduced in order to make the result fair and efficient.

3.4.1. Distribution of food donations

Feeding America is the largest aid organisation in the United States. Its most important task is to allocate the offered food to local food banks which distribute it to those in need. The distribution of donations raises a number of problems, in addition to logistical challenges, equity considerations are also involved, and ultimately the goal is to make the allocation efficient and to give the donations to those most in need. The allocation system has been drastically redesigned in recent years, as documented and analysed by *Prendergast* (*2016*).

In the previous system, food banks received offers for aid packages in a row, but these did not always meet their needs for quantitative or content reasons, since local needs may differ as charity organisations may also receive offers from other providers and local companies. The rejection of the offer, on the other hand, was a punishment: the food bank was left out of a round at that time, and this is why many times the package was accepted even if they could not distribute it ideally among those in need.

The new system is based on an artificial auction system where food banks receive tokens and can bid on aid packages on a daily basis. Under this system, they can make successful offers for packages of a quantity and content that can be put to good use by them. The system, which allows for a number of specialties, such as joint bidding, has proven very successful, with an annual increase in the total quantity of food allocated from 250 million pounds to 350 million pound in a short period of time.

3.4.2. Course allocation

At Wharton College, a combinatorial auction-based course allocation system developed in recent years by *Budish et al.* (*2017*) has been introduced which also uses artificial money. Each student receives roughly 5,000 tokens that they can spend on enrolling in courses in an artificial auction powered by an optimisation algorithm.

Students can submit their valuations on each course at a value in between 0–100 which they can then refine into pairs of courses so that complementarities can appear in the evaluation. This is a compromise assuming total additivity – where the value of the course package is the sum of the values of the courses – which would be too simplistic, but if all course packages could be valuated, it would require students to evaluate an exponentially increasing number of packages, which is not feasible. Based on the value of the course packages, the goal of the optimisation algorithm is to calculate a competitive equilibrium, which means an object allocation and artificial prices at which each student receives the most valuable course package from their budget according to their given valuations. Such solution does not always exist for valuations involving complementarities, but a well-defined approximative solution can always be found, the theory of which was developed by *Budish* (*2011*).

In Hungary, almost every university uses the first-come-first-served course allocation mechanism which is a default setting in the central administrative system, called Neptun. Although it leads to a Pareto-efficient solution, it is very unfair and causes permanent stress for the students and the servers crash at the universities. The only alternative course allocation mechanism in Hungary is the priority-based system of Eötvös Loránd University, but it also has unavoidable flaws. The alternative based on the above combinatorial auction provides an efficient solution while being fair, as Budish proved that, for example, the solution fulfils the property that no student envies another student's course package after taking out a single course from it. This is a surprisingly strong property since it is impossible to give a solution without envy even with two students and a single course. For example, if there are two very good courses and two definitely worse courses for two students, then in Budish's solution it is guaranteed that each one of the students will get one of the good courses, while in the first-come-first-served solution both good courses will be obtained by the faster student.

4. New interdisciplinary scientific areas

The study of the functioning of markets was given a central role in Adam Smith's first book, from the beginning of economics. According to his intuition based on philosophical understanding, the market creates an equilibrium situation with the help of an invisible hand, which is shaped by the individual interests of the actors,

but is still optimal for society. The exact mathematical proof of this statement is still the subject of articles showing the existence of such an optimal equilibrium situation in game theory models and the fact that self-interested actors can reach such a situation in a natural process (*Chen et al. 2016; Biró et al. 2014*). This market convergence can be very slow and costly in reality, even if it can be proved in more complex markets. Auctions are mechanisms that help the work of the invisible hand and accelerate it drastically, especially if supported by optimisation algorithms as well.

Game theory became well-known in the scientific research with the publication of the book by *Neumann and Morgenstein* (*1944*) and developed as part of mathematics and operations research in the 1960s. The initial theories applied to non-cooperative models, where participants acted according to their own interests throughout the game, with the goal of maximising individual benefit. Outstanding among the solution concepts is the Nash equilibrium, which means a choice of strategy and a related solution from which no player has an interest in deviating individually. Cooperative models have also emerged since the 1960s, which assume that groups of players can generate added value. The question here is what groups will work together and how they will share the extra benefits with each other (through payments or otherwise).

The basic toolbox for examining auctions is also represented by the game theory models, which were used by the Nobel laureates as well. In cooperative game theory, to study the market of sellers and buyers, the so-called assignment game (*Shapley – Shubik 1971*) and its generalisations represent the basic models, as mentioned earlier.

In the 1970s, mechanism design emerged as a branch of game theory for which Leonid Hurwicz, Eric Maskin and Roger Myerson were awarded the Nobel Prize in Economics in 2007. Here again, the goal is for participants who are considered rational and self-interested to achieve a fair and in some way optimal outcome in a given social or economic situation. The novelty in this is that the rules of the game and the procedure used can also be specified by the designer, who may also have an interest of his own, independent of the participants. In the case of spectrum auctions, for example, the central organiser, the government, apart from keeping the revenue level high, is also interested in having an efficient solution, i.e. that the winners can make good use of the acquired rights. The organiser is free to choose the auction procedure.

As part of the procedure, there may be also complex, direct functions in the mechanism. This means that the participants provide certain information (such as bids or selected packages for auctions) and, depending on these, the mechanism can move to the next decision point maybe after using a complex algorithm.

It remains an important question whether a given mechanism can be manipulated by individual or group strategies. If so, the analysis of the final result should be conducted with extreme caution. But the fact that a mechanism is strategy-proof in theory does not mean that it will not be manipulated in practice, such as the deviation from real values in second-price auctions. Furthermore, the manipulable mechanism will not necessarily be manipulated by participants by giving false valuations in practical applications, as this may also involve a risk, i.e. an expected loss; and manipulation strategies in the Bayesian sense can also be calculable, where actors rationally maximise their expected utility through their decisions, and therefore the process can be well analysed and can lead to good results at the system level as well.

The development of algorithms and optimisation functions used in the mechanism requires the involvement of computer scientists, because there can be a theoretically correct and even strategy-proof procedure, it is with no avail if its exact computation is not possible quickly in a large market. In multi-object markets, computing optimal solutions can often lead to NP-hard problems for which no fast (polynomial runtime) algorithm can be expected. For this reason, for example, the VCG mechanism is often not feasible in practice, because in addition to determining the final allocation, accurate calculation of the optimal solutions in the sub-markets is required for pricing as well.

Because of these considerations, computer scientists have been involved in the design of many auction applications, and as a result, the above areas have also become interdisciplinary. Algorithmic game theory, algorithmic mechanism design, computational social choice, economics and computation are all areas that have developed in the last decade with their own journals and conferences, such as the 22nd ACM Economics and Computation Conference (http://ec21.sigecom.org/) planned to take place in July 2021 in Budapest. Here, the field of auctions is a main topic, and it is no coincidence that this conference series is regularly supported by companies such as Google, Facebook, Microsoft, Amazon, where auctions are designed by research teams of economists and computer scientists.

In some markets, such as spectrum allocation or the energy market, the solution must meet special technological requirements as well, so the involvement of engineers is also required for design. However, this is not the only reason why the two Nobel laureates listed the task of designing auctions as a new topic in market design and economic engineering. On the one hand, market designers need to have a wide range of theoretical knowledge in the fields of economics, game theory, mechanism design and computer science, building the market models on the laws of these fields of studies. In addition, in practice, it is often necessary to go beyond the framework provided by theory. The expected decisions of market participants need to be well estimated in the system, which can be aided by both

practical observations and laboratory experiments, similarly to the observation and laboratory testing of the laws of physics, and the statistical analysis and scientific analysis of data can help in redesigning and fine-tuning market mechanisms including auctions or other matching mechanisms, similarly to how we can see the design and implementation process in the engineering sciences. An essential difference, however, always remains: market participants are not molecules or bearings, but those who make individual and group decisions that are often influenced by less rational, internal psychological reasons. This is dealt with more deeply in behavioural economics, and Richard H. Thaler received the Nobel Prize in 2017 for his research in this area. But just as important is the information aggregated by groups and networks and the individual and collective decisions based on them, an area that also has a prominent Stanford expert, Matthew O. Jackson, who may be a future Nobel laureate.

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The Role of the Compliance Function in the Financial Sector in the Age of Digitalisation, Artificial Intelligence and Robotisation*

Gábor József Harkácsi – László Péter Szegfű

Our analysis is intended to fill a gap in the sense that the focus of our study is on the challenges of the compliance function and their responses, putting into complex perspective the lack of and the need for striking a delicate balance between the quality of the international and national legislative environments and the role of ethical and due diligence frameworks. As a result of digitalisation, FinTech enterprises have become unavoidable in the world of financial services, which has had the effect that the business and risk models of incumbent players have changed, exerting a strong influence on the regulatory environment and in parallel on the development and change of trust and reliability as well as ethical and prudent conduct. Inevitably, regulation will always fall behind new needs and new emerging technologies, since authorities need to develop a thorough understanding of the functioning and risks of these technologies in order to establish adequate regulation of them. The compliance function must find its place and role in this changing environment in order to be able to efficiently support financial sector participants in their duty to comply with rules and ensure fair and ethical conduct.

Journal of Economic Literature (JEL) codes: D18, D53, E58, G01, G21, O33, O52

Keywords: digitalisation, artificial intelligence, ethics, compliance, trust, banks, FinTech, PSD2

1. Introduction

A number of studies and articles have been published in international and national professional literature, examining the modern-day role of trust and ethics and seeking answers as to how trust, reliability, ethical norms and ethical conduct are changing in the FinTech space. These publications, including this paper, all confirm that the role of ethics is important, since it already provides a guide for control

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and accountability, even before comprehensive regulation of the FinTech space is completed. The studies also predict that the norms of ethics and conduct as well as the incomplete international regulations currently applied will be evaluated in the event of an economic slowdown or recession. Trust is fundamentally based on smooth cooperation, the experience of addressing issues together, ethical behaviour and a mutual moral commitment. In business relations, trust creates trust and the trust gained will create a presumption of reliability. Lack of trust, however, is detrimental and leads to a lack of willingness to cooperate and, ultimately, to damage to the business relationship. The role and responsibility of the compliance department in ensuring compliance and ethical behaviour, and thus in creating and maintaining trust and reliability, is extremely complex. On the one hand, as part of the internal control system of the organisation, it is responsible for identifying and managing organisational compliance risks.[1] On the other hand, a compliance department is not only an organisational unit or function, but also a complex system and a mental attitude that must be put into practice, throughout the entire organisation. Regarding the latter, organisational and functional independence along with firm support from top management and strong networking at the organisational level are necessary conditions.

The financial sector, and in particular the banking sector, has always operated on the basis of trust and consequently it has considerable experience in how to operate ethically and how to build up and maintain the trust of clients and the market; it also knows how quickly all of this can be lost. Rebuilding and regaining trust and reliability, as has become repeatedly clear after economic crises, is a slow and difficult process. Trust, reliability, ethics and good business reputation are valuable assets and at the same time they are tools for successful operation and profitability (*Müller – Kerényi 2019*).

The question, however, arises as to how ethical requirements, professional standards, applicable regulations change and transform when FinTech[2] players of the financial sector (hereinafter: FinTech) enter the financial services industry as enterprises that offer innovative financial solutions,[3] forcing traditional credit

[1] Compliance risk is defined as the risk of legal or regulatory sanctions, major financial loss or loss to reputation an institution may suffer as a result of its failure to comply with any laws, rules, regulations, guidelines of self-regulating bodies or ethical norms pertaining to its activity.

[2] Financial technology (hereinafter: FinTech) is an umbrella term for innovative products and services created in a digital environment and performed using digital devices with the aim of widening the range of services in new competition with financial services provided by the institutions of the financial sector (credit institutions, insurance companies, investment service providers, funds, other payment institutions, etc.), in order to make clients' use of the given service more convenient, faster and/or cheaper or to generate new client demands with an innovative approach. At the same time, FinTech also applies to a new industry that uses innovative technology to improve financial activities.

[3] FinTech enterprises are those actors that create FinTech applications for classical financial institutions, credit institutions, insurance companies, brokers, etc. or for the purpose of providing a separate service independently of them. FinTech applications include account information service providers (AISP) and payment initiation service providers (PISP) under PSD2, while they are commonly called third party providers (TPP).

institutions, banks, insurance companies and other financial institutions to transform their business models, not to mention that we also must respond to the challenges facing us, such as the consequences of the new coronavirus pandemic on digitalisation. Digital technologies are changing our lives: artificial intelligence, big data analytics, block chain and cloud-based technologies are improving our world in several ways, but while opening up new opportunities, they also bring new vulnerabilities, more scope for errors, and consequently previously unknown risks. The regulatory environment, however, will always fall behind the quick development of emerging new technologies, since regulators must first understand the practical functioning and risks of these technologies so that they can create adequate but not excessively restricting rules. The uniform requirements needed for an unimpeded building of the digital financial structure have been met only partially, and therefore, as a bridging solution, ethical and confidence requirements as well as business codes of conduct have been brought to the fore.

2. Threats and responses

The new technologies tend to bring considerable benefits worldwide, but they also pose risks. Major benefits include quick client acquisition, enhanced user experience, cost reduction, efficiency gains and a higher degree of transparency. Apart from this, innovation is an efficient tool to combat financial exclusion by offering high quality services to those who previously were not able to afford them. As one of the largest users of digital technologies, the financial sector plays a major role in the digitalisation of our economies and societies. FinTech enterprises providing financial services are breaking up a centuries-old monopoly in the field of traditional banking and financial services, opening up new channels for clients. Their entry to the market intensifies competition, but it also poses threats and new risks in addition to an aggravation of the already known operational and security risks, while their operation raises fundamental regulatory and social questions. The risks detected may worsen for several reasons. The main reasons include the fact that as a result of the emergence of a large set of new technologies in recent years and the open use of financial services (for example, open banking), the appearance of new services focusing on delivering user experience has quickly altered the dynamics of competition and business models have also changed at a more rapid pace. FinTech enterprises have the potential to penetrate the market of traditional financial services actively and more successfully, and the digital technologies applied in the course of providing their services – in particular where closely integrated into the operation of financial institutions and with access to sensitive customer data – have opened up a new dimension of operational risks. Access to customer data may generally occur through the Internet and through communication between interfaces, while the management, processing and storage of these data is mostly carried out through cloud computing services. As a result,

the technological solutions applied to services pose risks due to the nature of the Internet and due to the different security levels of the solutions provided by the many Internet user contractors involved in the service.

Taking all these risks into account and in particular the fact that FinTech enterprises usually provide their services managing cross-border and Internet-based services, it has been an essential step, in the interest of protecting the security of users, to tighten the standardised security requirements throughout European Union and to ensure a high level of consumer protection for the use of these services.

2.1. Tightening of the rules for payment services

The European regulator with the involvement of the European Central Bank (ECB) and the European Banking Authority (EBA), has developed a stricter regulatory framework for the provision of payment services, and thus on 12 January 2016, PSD2[4] entered into force and Member States had to transpose it into their national laws by 13 January 2018. In addition to the aim of ensuring effective protection for customers – especially for consumers – PSD2 was put into place to create a regulated environment for the development of digital financial services, to support new providers including those without a credit institution background in entering the financial services market and to further increase the security of payments in view of the growing expansion of online transactions. At the same time, PSD2 opens up huge opportunities for FinTech players, also called third party providers, by granting them access to their customers' payment accounts. The task of ensuring the protection of customers' personal data falls under the scope of the General Data Protection Regulation (GDPR[5]) and the respective national legislation. Protection of data that qualify as a financial sector secret is regulated by the respective laws of the financial sector, while regulation relating to sensitive payment data is set out in the additional provisions[6] of the Act on Payments Services.[7] Under PSD2 and payment regulations transposing PSD2 into national law, in the course of providing their services, third party providers can access their customers' payment accounts data subject to the consent of the customer and to the extent that it is absolutely indispensable for providing the service.

[4] Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC

[5] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC

[6] Under section 2 (5a.) of the Act on Payments Services, sensitive payment data means data, including personalized security credentials which can be used to carry out fraud with the provision that in respect of payment initiation services or account information services, the name of the account owner and the payment account number do not constitute sensitive payment data.

[7] Act LXXXV of 2009 on the Pursuit of the Business of Payment Services

2.2. Strengthening the protection of data

According to the provisions of the respective laws, it is typically the responsibility of the service provider to ensure the proper protection of customer data. By providing for severe sanctions, adoption of the GDPR has further tightened the already strict approach of financial institutions towards data protection and data security. Unfortunately, the GDPR only applies to personal data, and thus service providers sought to tailor their rules and solutions for data protection and data security to the personal data of their customers, paying no attention at all to the fact that service providers may access other sensitive data, only some of which fall within the category of personal data.

In order to ensure proper data security, it is indispensable that market participants conduct a comprehensive assessment of the data assets they manage, including – in addition to personal data – data classified as secrets by the respective laws of the financial sector, trade secrets, data that are publicly available but to be actually protected, and sensitive data for which there is no legal regulation but may affect the proper functioning, security or even the market position of the institution. Data and data management systems must be classified into different security categories. The three main pillars of information security are confidentiality, integrity and availability. It is also necessary to assess the risks for the information security categories and to take adequate measures to address these risks, taking into account the respective legal provisions as well as the respective ethical and social expectations and norms.

2.3. Customer due diligence; opening and regulation of new possibilities for remote contracting

The increasingly stringent anti-money laundering directives and regulations of the EU,[8] along with the AML Act transposing them into national law and the MNB Decree[9] on its implementation provide fundamental guarantees necessary to protect the integrity of the European financial system against money laundering and terrorist financing. In addition, the AML Act and the respective MNB Decree opened up new possibilities for the rise of innovative financial technologies. In some cases, particularly where institutions falling under the effect of the Act[10] establish relations with new customers,[11] service providers are required to execute the so-called customer due diligence. Already at the time of entry into force in 2017, this

[8] The MNB offers a collection of links to the respective norms on its website: https://www.mnb.hu/en/supervision/regulation/anti-money-laundering/requirements-and-guidance/eu-regulations
[9] MNB Decree 26/2020 (VIII.25.) on the detailed rules concerning the implementation of the Act on the Prevention and Combating of Money Laundering and Terrorist Financing, as applicable to service providers supervised by the MNB, and concerning the minimum requirements for the development and operation of the screening system under the Act on the Implementation of Restrictive Measures Imposed by the European Union and the UN Security Council Relating to Liquid assets and Other Financial Assets MNB Decree
[10] Section 1 (1) of the AML Act
[11] Section 1 (6) of the AML Act

Act opened up the opportunity for remote customer due diligence carried out in electronic form through audited electronic communications equipment. The Act authorised the MNB to specify the technological details. At the beginning, the MNB Decree preferred customer due diligence via video chat, the closest to personal appearance, while later it permitted several selfie-based identification solutions. The most recent version of the Decree allows the use of identification cards equipped with an electronic storage unit and the use of travel documents with an integrated chip containing biometric data for the identification of customers in respect of customer due diligence carried out for the purpose of preventing money laundering, which may significantly facilitate the remote acquisition of customers. As meanwhile the requirements of the written form under the Civil Code have been simplified, the MNB concluded that if the customer makes a legal declaration in the course of the customer due diligence process carried out for the purpose of preventing money laundering through audited electronic communications equipment and the service provider ensures unchanged quote of the legal statement, it will comply with the written form requirement of contracting. As a result, the process of remotely acquiring customers can run fully online without interruption even in cases where the law prescribes the written form. This offers significant support to FinTech players in customer acquisition.

3. Responsibility of regulatory actors

The responsibilities of the regulatory actors are twofold: on the one hand, they are of a supportive nature; on the other hand, they must consider security and other risks. They must ensure that legal constraints do not form barriers to the spread of new technologies and business innovation, and at the same time they must facilitate the entry of new market players, ensuring fair competition in a way that new players are not placed at a competitive disadvantage and the interests of traditional financial institutions are not affected either – and naturally all of this should be done with the security risks in mind. From a regulatory standpoint, it is also important to take into account the fact that the usability and the security of certain innovations are in inverse proportion to each other. Regulators must strike a balance that does not yet pose obstacles to the usability of solutions, but still provides enough security to preserve the financial stability of financial institutions, customers and Member States. It is, however, a major challenge for legislators to be able to follow the rapid technological development by establishing and amending the respective legislations, and under these circumstances compliance with and enforcement of ethical norms has a key role to play.

4. Trust, reliability, compliance and ethics in the digital world

4.1. Rapid development

Technology has progressed extremely rapidly, making a significant impact on our everyday lives, and the task of keeping pace with this rapid development presents a significant challenge for legislators as well. The change affected the financial sector in an exceptional way: in many cases banks were pioneers in applying new technologies which led to a reduction in their costs and at the same time to increased satisfaction among their customers. The vast majority of users welcome FinTech services, because the service is fast and much cheaper than traditional financial services, particularly the services requiring personal presence. However, the level of suspicion and the risk sensitivity of users with regard to the services – primarily among the young due to the insufficient information at their disposal – is rather low. The main motivations are convenience, quickness and cost saving. Banks are also constantly adapting to new technological opportunities and as a result their customer service is increasingly shifting towards electronic, in particular, Internet-based communication. Additionally, they are striving to keep up with FinTech firms by providing similar value-added services that focus on delivering user experience. In addition, the coronavirus pandemic has provided fresh motivation, and the measures taken in consequence have explicitly speeded up digitalisation. Within a short time, the financial sector switched to almost fully digital operations, in the context of which the scope of functions and services available through internet and mobile banking has widened. At the same time, the number of those customers – including all age groups, but mainly the elderly – who make use of these services in order to avoid having to personally visit a bank branch has increased significantly. In order to secure and retain the benefits offered by digitalisation, digital financial services providers utilise every available piece of digital technology for the provision of their services in the course of their operation, such as application programming interfaces (API), artificial intelligence, data analysis methods, robotics and the use of data collected or left behind. These data are collected and recorded through algorithms and programmed applications, and service providers provide their services or a part of their services in return for these data. They sell the data or use them for the provision of other services sold for money, which generates revenue. All of this has led to extremely rapid development whereby, with the variety of their services, the ever-growing FinTech enterprises represent and cover such a wide range of financial services that legislators find it rather difficult to keep up with the pace as regards the amendment of the currently effective and applicable legislations or the creation of new legal provisions. For this reason, it is particularly important that there be strong ethical norms. Developments and innovations should ensure consistent value enhancement for customers, while they are treated in a fair and ethical way.

4.2. Appropriate regulatory environment

One essential condition for development is to create and maintain an international and national regulatory environment which supports useful and valuable innovations, and at the same takes efficient and firm action against overly risky, unethical or harmful conduct (*MNB 2019*). Legal provisions, regulations and supervisory bodies must adapt to innovation and find the right balance between supporting and regulating innovation. Financial technology requires a balanced approach between regulation of the institution and regulation of the activity. This is necessary because, as a consequence of the complex interaction between technology and regulation, contradictions may arise. For example, it may happen that certain companies and service providers are regulated differently even if they carry out basically the same activities. Moreover, the current regulation takes the wrong approach to certain activities in terms of definition and/or scope of activities. The existing EU legislation is overly complex since a number of overlapping provisions relating to FinTech innovations are in force. In order to avoid placing FinTech players in a situation of competitive disadvantage, but at the same time to make sure that the interests of traditional credit institutions are preserved, it is necessary to ensure a standardised regulatory environment across the European Union. Regulation, however, is not yet complete; the procedure is still in progress. The next section presents the important areas where the regulation in force should be improved or supplemented.

4.2.1. Liability rules pertaining to new technologies

The question of legal liability is an issue that still needs further clarification. In the course of developments – such as customer risk analysis using AI technology, fraud monitoring, robo-advice, big data analysis – errors and distortions inherent in technology may even lead to a systemic risk and may cause harm to customers. However, it is not clear who bears the legal liability in such cases. Trustworthy artificial intelligence must comply with the effective laws and regulations. Determining liability is a serious issue, also because the working of the technology is not evident: it is based on algorithms which are not exclusively written by human beings. Furthermore, it is complex, unpredictable, non-transparent, and therefore when making its own decisions, it is not always possible to identify precisely where, how and why a potential mistake or error could have happened. For this reason, serious resentments have emerged against the technology. When setting up legal frameworks, it is important that the legislator minimise the risks posed by AI to the extent possible in a such way that sectoral specificities such as sectoral laws are taken into account. Regulation should prefer a people-centred approach and should protect the individual from possible asymmetries in automatic decision-making and help enterprises developing and implementing AI technology by providing legal certainty. It should not create competitive disadvantages or excessive administrative burdens and it should not hamper the appropriate development of technology.

At the same time, it should be technologically neutral and should consider international standards and regulatory frameworks. The EU has recognised that from the aspect of promoting European values, it is important that regulatory and ethical principles are defined at the EU level, and it laid down a high level European Union strategy for artificial intelligence,[12] in addition to setting out the principles in its White Paper on artificial intelligence (*European Commission 2020*). With the purpose of laying down Hungary's national regulation on AI, the Hungarian Artificial Intelligence Coalition was established on 9 October 2018 with the participation of 78 international and Hungarian companies together with universities, scientific workshops, professional and administrative organisations.[13]

In addition to the regulation of AI, the entry into force and application of PSD2, the AML Directives, the NIS Directive,[14] and the GDPR marked the start of the establishment of a necessary standardised European regulatory environment. As part of this process, European guidelines have been and are being specified on several topics, such as the use of cloud computing services and the application of artificial intelligence. This is important also because the management and processing of the sensitive data of customers and partners – in respect of both FinTech and incumbent players – is increasingly carried out by cloud computing applications and by systems relying on AI tools. Credit institutions and FinTech enterprises store and use the identification data, account number, payment transaction data and other personal data of their customers in order to provide personalised services to their customers. However, in order to ensure the proper protection of customer data, the responsibilities and competences of the data owner in respect of the entire process should be clearly defined. Compliance with the principles of data protection set out by the data owner must be enforced technologically or through the application of legal safeguards during the entire process, independently of whether data management or data processing is carried by different players. Artificial intelligence which supports the use and utilisation of data or optimises decision-making relating to data or based on data extraction, machine data analytics and robotics are already inseparable tools of the digital financial services and – as discussed above – it is the associated risks and prejudices that cast the most enormous shadow over FinTech solutions. This is where the requirement of trust and ethics is most apparent, since regulators primarily seek to regulate the FinTech services themselves, and it is more difficult to identify the technologies and tools used by these services and properly regulate the functioning thereof. According to the legislative intent, just as under PSD2, the duration of financial services provided by FinTech enterprises lasts until, for example, a FinTech enterprise providing account information services

[12] Artificial Intelligence for Europe, COM/2018/237 final
[13] https://digitalisjoletprogram.hu/en/content/artificial-intelligence-coalition
[14] https://ec.europa.eu/digital-single-market/en/directive-security-network-and-information-systems-nis-directive

forwards or makes available to the customer the data requested by the customer. Of course following this, customers may freely dispose of the data provided within the framework of the service, and for example with the acceptance of the service provider's condition that for the sake of the free use of the service, FinTech enterprises may transmit data collected by them to a third party (e.g. to accountants, to marketing companies to carry out targeted advertising or financial institutions providing loans to make personalised credit offers or to propose loan facilities), the further fate of the data, and the way the data is processed and used by a third party is less regulated, and thus less transparent and controllable. This data transmission cannot be considered as a service provided within the framework of the account information service, for example under law,[15] and thus the rules of PSD2 cannot be applied. Therefore, in the course of data transmission falling outside the scope of the service, FinTech enterprises must consider, besides the legislation governing data protection and more specifically the rules of the GDPR – among other things – the statutory provisions relating to the transmission of data classified as secrets by the laws of the financial sector (such as bank secrets under the Credit Institutions Act or payment secrets under the Payment Services Act[16]). In addition, it is also necessary to examine the application of rules on outsourcing and, in the light of the existing legal loopholes, the norms of ethics, behaviour, conduct and due diligence.

4.2.2. Identical activities, identical regulation

Based on feedback from the market, there is still no level playing field, since PSD2 leads to a large loss of data and market share for the banking sector if banks themselves do not launch costly digital developments. Third party providers experience distortion of competition in several respects as well. Although connection is made via open interfaces based on standard protocols, both third party providers and banks providing such services need to implement developments entailing significant costs for each connection. The costs and durations of these developments and the need to connect banking interfaces of various parametering, i.e. interfaces that are based on different standards[17] instead of a single, uniform standard and contain country-specific elements[18] raise the barriers to entry and slow down the introduction of new services to be provided by the banking sector under PSD2. Besides all of this, in order to avoid presumed or real loss of market, certain credit institutions are trying to hamper or restrict the ability of third party providers to connect by imposing mostly unethical but in some cases unlawful conditions or testing circumstances or procedures on the pretext of handling incidents that may have occurred. In an effort to facilitate a common interpretation of "obstacles" and

[15] Section 6 (1)101a. of the Credit Institutions Act
[16] Act CCXXXV of 2013 on Certain Payment Service Providers
[17] The two largest are Berlin Group and Open Banking
[18] E.g. special fields required for instant payment service in Hungary

the application of laws in relation to disputes, the EBA published its opinion[19] to clarify the definition and examples of obstacles under Article 32 (3) of the RTS on SCA and CSC,[20] and the MNB also published its tool of supervisory regulation on the secure communication relating to services provided by third party providers.[21]

With regard to the risks arising from services, FinTech enterprises including the operation of third party providers are subject to licensing or registration requirements in any case. With a view to enforcing identical principles, providers must go through a strict licensing procedure, but this does not mean that authorities hinder or impede the market entry of providers intending to operate with proper guarantees. When issuing licenses in Hungary, in order to ensure compliance with the strict conditions, the MNB offers a number of opportunities for facilitating licensing. To this end, it published a detailed guide[22] and a summary of frequently asked questions[23] and facilitates the market entry of new financial solutions via other supervisory innovations.

4.2.3. Strong customer authentication

Another fact that represents a considerable competitive disadvantage for third party providers is that the EBA provided the national supervisory authorities of the Member States with the opportunity to extend the deadline for banks and other payment service providers to comply with the legal provisions on strong customer authentication until 31 December 2020 concerning e-commerce card-based payment transactions, but at the same time, third party providers were not given the opportunity to omit the application of strong customer authentication in the course of the provision of their services. PSD2 set the date at 14 September 2019 from which banks and other payment service providers – in order to provide customers with online access to payment accounts or to electronic payments – must apply the provisions on customer authentication requiring the application of strong, at least two-factor authentication (for example PIN code and fingerprint or a password and SMS code). However, taking into account the complexity of the regulation as well as the request and lobbying activity of card issuers and merchants, the EBA, as coordinator of the work of the national supervisory authorities, allowed the supervisory authorities of the Member States to provide additional time for completing IT developments and migrating to the new customer authentication

[19] https://eba.europa.eu/sites/default/documents/files/document_library/Publications/Opinions/2020/884569/EBA%20Opinion%20on%20obstacles%20under%20Art.%2032%283%29%20RTS%20on%20SCA%26CSC.pdf
[20] Commission Delegated Regulation (EU) 2018/389 of 27 November 2017 supplementing Directive (EU) 2015/2366 of the European Parliament and of the Council with regard to regulatory technical standards for strong customer authentication and common and secure open standards of communication
[21] https://www.mnb.hu/letoltes/vezetoi-korlevel-a-fizetes-kezdemenyezesi-es-szamlainformacios-szolgaltatasokhoz-kapcsolodo-biztonsagos-kommunikacioval-2020-07-13.pdf
[22] https://www.mnb.hu/felugyelet/engedelyezes-es-intezmenyfelugyeles/engedelyezes/szektorok/penzpiac/penzforgalmi-intezmeny/kizarolag-szamlainformacios-szolgaltatast-vegzo-penzforgalmi-intezmeny-bejelentese, https://www.mnb.hu/letoltes/penzforgalmi-intezmenyek-tevekenysegenek-engedelyezese.pdf
[23] https://www.mnb.hu/penzforgalom/psd2-gyakori-kerdesek-es-valaszok/engedelyezes

procedures relating to e-commerce card-based payment transactions until 31 December 2020. During this transition period, customers of banks and other payment service providers were allowed to use their payments cards for online domestic and cross-border payments without the application of strong customer authentication.

4.2.4. Fraud prevention

The opportunities offered by digital technologies, open banking and instant payment essentially brought about a paradigm shift that led to the alteration of the related risks, such as the risks of fraud. The involvement of various actors makes the system more complex, meaning that payment transactions are now executed with the joint participation of 5-6 actors, all being potential target, and thereby constituting potential new vulnerable points or targets for attacks. This may lead to the alteration of the risks of fraud and the emergence of other, currently hidden risks. The increase in these risks may cast a shadow over FinTech, and therefore it is vitally necessary for the regulatory environment to be adaptable to this change. Although PSD2 and the related RTS on SCA and CSC provide that a modern monitoring system must be operated for the detection of unauthorised transactions and fraudulent payment transactions, the application of this requirement in real time is only mandatory under certain conditions.[24] This, however, means that the risks of the so-called instant fraud[25] arising from the peculiarities of instant payment are only partially addressed. A modern monitoring system must be able to analyse activity and device risks for all users (including third party providers) and of each digital channel in real time (taking into account that instant payments are executed in just a few seconds) and it must respond to suspicious events and known fraud scenarios. However, considering the requirements of the RTS on SCA and CSC, the operation of a monitoring system in real time is currently not a statutory provision of general application.

A modern monitoring system must also be able to hold its ground in a crisis situation. The coronavirus came as a new shock to the world economy and the financial sector had very little time to react. As the population was forced into lockdown, it was necessary to switch to almost fully digital operation, in the context of which the scope of functions and services available through Internet and mobile banking has widened. As discussed above, the clientele that makes use of these services in order to avoid making a personal visit to a bank branch has also grown. However, a significant risk is posed by the fact that many of these new customers, particularly the elderly – who are at the highest risk from the coronavirus

[24] Based on transaction risk analysis, a remote payment transaction can be considered as low risk and the use of strong customer authentication is not required.
[25] The risk relates to the fact that the money is transferred to the fraudster within 5 seconds, and therefore the prospects of recovering the stolen money are minimal.

– have never used digital banking services in the past, and therefore criminals can easily exploit and do exploit the lack of knowledge and experience. With the development of digital technologies, fraud is becoming increasingly sophisticated and, amid coronavirus pandemic, the number of fraud attempts and the frequency of successful fraud have also increased globally (*Javelin Strategy & Research and SAS 2020*). The increased number of transfers and card not present (e.g. online bankcard payments) resulting from the growing clientele – together with the fact that the previously offline generation has lower levels of knowledge in the field of digital banking services – puts a heavy additional burden on the compliance departments of financial institutions concerned to prevent fraud and abuse. It is particularly problematic that fraud detection and prevention is a special area that still has limited available competences. Fraud detection systems also increasingly apply solutions of artificial intelligence and although they prove to be efficient, they raise several regulatory-related questions, such as, from the perspective of data protection, forbidden accumulation of data, profiling subject to strict requirements, compliance of targeted data processing, provisions on data storage or processing of data falling within the scope of sectoral secrets. Account should also be taken of the fact that, besides the compliance and ethical issues in relation to solutions supported by artificial intelligences discussed above, the storage and processing of data is mostly carried out through cloud computing services, which may raise further data protection, confidentiality and ethical concerns.

4.2.5. Outsourcing and the use of cloud computing services

While offering the advantage of cost-efficiency and ease of use, cloud computing services which are becoming increasingly popular among financial institutions and third party providers involve a number of risks, including – but not limited to – the inherent element of service models that service providers offer the same or similar services to different institutions, and therefore it is necessary to ensure that data is separated in a proper and secure way. It is important that not only other users of the services, but also the very service provider or its contractors should be prevented from gaining access to data, except where control measures are taken – under a contract – and the participants involved are only allowed to handle data as specified in the contract. Another risk to be highlighted is the exit strategy, since – primarily in the Software as a Service (SaaS) model – the institution may lose control over the processing of their data as well as over the proper possession of processed data and the further possibilities of data processing.

Be it the outsourcing of single solutions or the infrastructure to an external service provider, it is necessary to focus in all cases on compliance with the respective EU, national, sectoral laws and supervisory regulatory norms. The term of outsourcing is defined differently in Hungary's national legislation and in EU legislation: in Hungary's laws the term of outsourcing is distinguished from the general

subcontracted activities. Unfortunately, sectoral laws give different meanings to the term "outsourcing". The Credit Institutions Act, the Investment Firms Act,[26] the Act on Voluntary Mutual Insurance Funds[27] and the Act on Private Pension Funds[28] link outsourcing to data management and impose strict contractual requirements on institutions, while, for example, under the Act on Payment Service Providers[29] or the Insurance Act,[30] outsourcing is the activity that could be undertaken by the institution but is performed by an external service provider under a contract. Besides, the Collective Investment Undertakings Act[31] explicitly excludes the development of IT systems and the operation and maintenance of IT systems from the scope of outsourcing. In respect of the application of legal requirements for outsourcing, the MNB provides guidance in its supervisory regulatory tools.[32] The use of cloud computing services mentioned above – provided it complies with the respective provisions of sectoral laws – must also be treated as outsourcing, but in the course of the use of this service, special attention should be paid to the specificities of the technology. In respect of the applicable norms, the MNB provides guidance in a special supervisory regulatory tool.[33]

However, independently from the fact whether the use of third party providers is through outsourcing or subcontracting, institutions are required to exercise due care and comply with ethical, moral and prudential norms – particularly where the use of third party providers includes customer data or communication with customers – even though these norms are not based on legal requirements.

4.3. Confidence building, fair and ethical behaviour

4.3.1. The ways to build trust and reliability have changed

Trust, reliability, ethical conduct together with good business reputation are expectations and professional requirements, compliance with which has value, and they also form the basis for successful operation and profitability. As regards

[26] Act CXXXVIII of 2007 on Investment Firms and Commodity Dealers, and on the Regulations Governing their Activities
[27] Act XCVI of 1993 on Voluntary Mutual Insurance Funds
[28] Act LXXXII of 1997 on Private Pensions and Private Pension Funds
[29] Act CCXXXV of 2013 on Certain Payment Service Providers
[30] Act LXXXVIII of 2014 on the Business of Insurance
[31] Act XVI of 2014 on Collective Investment Trusts and Their Managers, and on the Amendment of Financial Regulations
[32] MNB Recommendation 7/2020 (VI.3.) on the usage of external service providers is directly applicable to outsourcing, MNB Recommendation 27/2018 (XII.10.) on setting up and using internal lines of defence and on the management and control functions is applicable to inspection duties, while MNB Recommendation 8/2020 (VI.22.) on the protection of information systems discusses the management and monitoring of IT outsourcing in separate chapters.
[33] In terms of managing cloud computing specific risks, the MNB expects the application of Recommendation 4/2019 (IV.1.) on the usage of community and public cloud computing services which includes the recommendations the European Banking Authority on outsourcing to cloud service providers of 20 December 2017 (EBA/REC/2017/03 https://www.eba.europa.eu/sites/default/documents/files/documents/10180/2170125/e02bef01-3e00-4d81-b549-4981a8fb2f1e/Recommendations%20on%20Cloud%20Outsourcing%20%28EBA-Rec-2017-03%29_EN.pdf?retry=1). Although the EBA repealed the recommendation on cloud outsourcing, it incorporated the requirements formulated in the Recommendation into its Guidelines on outsourcing arrangements (EBA/GL/2019/02)

FinTech enterprises, in the initial period, there was no particular need to build trust, and regulation was loose and permissive. With the advent of Internet and digital technologies, the ways to build trust and reliability have changed. Trust and reliability increasingly tend to be the outcome of communication between customers as well as recommendations by other customers and their network of personal contacts. However, the increasing number of complaints about phishing or about the collection, management and use of personal data, primarily handled in the course of the provision of a service or left behind, that is not even known to the user of the service, who is also the owner of data, highlights the drawbacks of FinTech services and the risks related to the use of these services. FinTech enterprises are creating exciting new products and value-added services in response to customer needs, utilising technologies, such as artificial intelligence, robotics and machine learning. Traditional credit institutions have also initiated innovative developments, and they have established several types of partnerships with service providers emerging in this field, or have simply acquired the novel solutions together with the FinTech start-ups themselves, integrating them into their own operations. Digital technologies and now also open banking coupled with the opportunities offered by instant payments have altered the risk profile of traditional credit institutions as well. It is therefore important that regulation by virtue of legal provisions alone is not sufficient: it is also necessary to set requirements for fair and ethical conduct. In order to manage the changed risk profile, in addition to an efficient regulatory environment, we need an efficient compliance and internal audit programme. An appropriate and continuously maintained compliance and internal audit programme can provide a solution for exploring new, potentially hidden threats and managing the identified risks in a proper way. The key pillar of an atmosphere of confidence and reliability is the prudent and ethical operation which, however, requires the commitment of the management, and it is also vital to make sure that employees know and comply with the respective legal provisions, rules and ethical norms. This can be achieved primarily by improving awareness and providing continuous information and education, and by executing periodical – planned – audits. It is an example of exemplary practice, if the compliance department, in fulfilment of its consultative, guidance and preventive duties, can provide, on a continuous basis, satisfactory responses to the relevant questions of employees either personally, on the phone, through electronic channels or, in certain cases, anonymously, for example acting as a whistleblower. However, it should also be taken into account that FinTech enterprises utilise every available piece of digital technology for the provision of their services, and therefore norms of ethical conduct must be determined and enforced not only in relation directly to FinTech and digital financial services providers, but they must imperatively be extended to cover the tools, technologies and solutions indispensable for their activities, thereby regulating the

toolbox of FinTech and BigTech financial services, including for example artificial intelligence and the use of data managed or left behind within big data.

4.3.2. Development of ethics and due diligence frameworks

When formulating and implementing a compliance programme, in addition to ensuring compliance with legal requirements, the compliance department must also pay particular attention to the duty of care. This obliges compliance departments to monitor not only whether enterprises, in the course of their activities, comply with the effective laws, but also whether what they do is right and that the requirements of trust, reliability and ethics are also not compromised. In this context, it is an important compliance task on the one hand to promote an ethical culture, keeping the management and employees informed about what is right and what is not acceptable and on the other hand to establish the foundations for raising compliance awareness and to familiarise employees with these foundations. Recognising the risks faced by the intermediary system and money markets, there is a process underway in parallel with the elaboration and the implementation of the necessary legislation to develop ethics and due diligence frameworks, extending the norms to FinTech enterprises and to the tools used by them. In April 2019, the European Commission published a document entitled "Ethics Guidelines for Trustworthy Artificial intelligence" (*European Commission 2019*) with the aim of promoting the use and development of trustworthy artificial intelligence.

Trustworthy AI displays three components which should be ensured throughout the system's entire lifecycle: it should be lawful, complying with applicable laws and regulations; it should be ethical, ensuring adherence to ethical principles and values; and it should be robust, both from a technical and social perspective, since, even with good intention, AI systems can cause unintentional harm.

Laws are not always up to speed with technological developments: at times they can be out of step with ethical norms or may simply not be well suited to addressing certain issues. However, for AI systems to be trustworthy, they should also be ethical, ensuring alignment with ethical norms.

4.3.3. Prudent, ethical conduct towards customers

The application of ethical procedures towards customers plays an ever more prominent role these days. The role of consumer protection authorities is increasingly strong and as a result trust in the financial intermediary system and its supervision is gradually increasing. Customers may contact supervisory authorities with their complaints – if they do not receive a satisfactory response from the financial service provider – and submit a customer protection complaint in individual cases, or a public interest disclosure in case of infringement or systemic

problems affecting other consumers[34] as well. Disputes between consumers and financial institutions can also be settled out of court via the forum of Financial Arbitration Board.[35]

A condition to be satisfied for prudent operation is the provision of appropriate, comprehensive information to customers already prior to contracting, in due time and in a verifiable way. There are several legal provisions pertaining to the obligation of providing information to customers, from data management to the creation of conditions for proper decision making relating to the use of the service, however laws do not cover every issue here either, and therefore diligent, ethical and prudent conduct has a special role in providing adequate information to customers.

Besides the rules of the GDPR, the respective sectoral laws also include provisions on data management. In the case of using outsourcing services, credit institutions must inform their customers, also in the standard service agreement, on who may access sensitive data in the course of data processing.[36] Although there is no legislative requirement to do so, the fair practice of an institution includes making the entire outsourcing chain transparent to customers.

Consumer protection requirements under the respective law[37] protect customers that qualify as consumers. A key ethical question is that customers not qualifying as consumers should also receive similar protection in the context of the applied procedures.

With a view to facilitating the application of respective legal provisions and laying down prudential expectations, the MNB published a tool of supervisory regulation.[38] Since neither the legislative nor the regulatory norms can be fully comprehensive, institutions must provide for fair and acceptable procedures, apart from the legal obligations. A further expectation is that institutions should consider themselves to be bound by the respective codes of ethics and conduct as well as decisions made by the Financial Arbitration Board.

The principles of fair procedure include the principle of ensuring the use of services for all persons with disabilities through appropriate technical solutions, and as far as possible in standard quality, providing the same level of customer experience.

[34] According to the provisions of Act CLXV of 2013 on Complaints and Public Interest Disclosures and to Act CXXXIX of 2013 on the Magyar Nemzeti Bank
[35] https://www.mnb.hu/en/hungarian-financial-arbitration-board
[36] According to the provision of Section 68 (12) of the Credit Institutions Act
[37] Act XLVII of 2008 on the Prohibition of Unfair Commercial Practices against Consumers
[38] MNB Recommendation 10/2016 (X.24.) to financial organisations on the application of consumer protection principles

5. Conclusions

Up to now, the requirements needed for the smooth building and development of digital financial infrastructure have been met only in part, and thus, as a bridging solution, ethical and confidence requirements as well as business codes of conduct have been brought to the fore. Compliance departments in companies operating in the financial sector have a crucial role to play, since due to the incomplete state of the regulatory framework, this is the area which is tasked with ensuring compliance with legal provisions and other applicable recommendations, ethical norms, guidelines and guidance and with identifying and addressing compliance risks inherent in the activities of an organisation. It is not enough only to monitor whether the provision of services complies with the effective laws, but it is also necessary to monitor that requirements of trust, reliability and ethics are not compromised. This task is made more difficult given that a compliance department has to hold its ground in a continuously changing and developing regulatory environment in a period where the consequences of the coronavirus pandemic affecting economic and financial life have reached the digital world, too. However, just as every crisis, the current one caused by the coronavirus pandemic, whilst carrying significant risks, presents an opportunity. Social distancing rules introduced as precautionary measures have moved many activities into the online space, as a result of which consumer behaviour has drastically changed, facilitating the digitalisation of processes. Also in Hungary, digitalisation has been considerably encouraged by the quick and efficient answers given to the coronavirus pandemic situation and to the inherent difficulties, and that response has also strengthened the country's competitiveness in the longer term. Numerous new digital services have been introduced, and the measures taken as a result of the pandemic have explicitly speeded up the emergence of digital projects. In particular, limitations on customer services rendered through physical presence and on customer service performed in bank branches have contributed to a quicker development of options for digital contracting, remote customer identification and electronic payment. Within a short time, the financial sector switched to an almost fully digital operation, in the context of which the scope of functions and services available through electronic customer channels (on web-based and mobile platforms) has widened and at the same the clientele that makes use of these services has also grown. Besides the aspect of convenience, this is due to the efforts to reduce pandemic risks through measures to limit personal interactions. However, a significant risk is posed by the fact that many of the new customers, particularly the elderly who are at the highest risk from the coronavirus, have previously not used digital banking services, and therefore criminals can easily exploit their lack of knowledge and experience. Although the younger generations favouring FinTech services have well-developed digital and online skills and believe in quick, cheap and convenient payment solutions, their financial and security awareness is not in line with their skills, and thus they are also

faced with the risk. Apart from the risk posed by the lower level of knowledge of the previously offline generation in the field of digital banking services, the increased number of transfers and card not present transactions (for example online bankcard payments) also puts a heavy additional burden on the compliance departments of the financial institutions concerned in fraud and abuse prevention which serves the interest of both the banks and the customers.

Due to the development of digitalisation, robotisation and artificial intelligence and due to the emergence of economic and financial problems resulting from crises, in this case from the coronavirus pandemic, regulators must continuously respond to new risks. As mentioned above, regulation – necessarily – will always fall behind new needs and new emerging technologies, since the authorities need to develop a thorough understanding of the functioning and risks of these technologies in order to establish adequate regulation of them. And, in any case, rules – as the saying goes – are valuable only to the extent we can follow them. The role of ethics is therefore crucial in the global world, because the rules of co-existence satisfactory to all must be planted into the thinking of society along with ethical principles and objectives. For a global world, we need to formulate, establish and apply ethics that go beyond individual interests and economic profit maximisation in a modern sense. The objective must be to ensure a decent standard of living, security and sustainability for the whole of humanity and in order to achieve this the compliance department must be ready to perform its respective tasks.

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When Success is Not Good Enough*

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Dietrich Vollrath:
Fully Grown: Why a Stagnant Economy Is a Sign of Success
University of Chicago Press, 2020, p. 296.
ISBN–13: 978–0226666006
Hungarian translation:
A beérett gazdaság – A stagnálás mint a siker jele
Pallas Athéné Könyvkiadó, 2020, p. 303.
ISBN–13: 978–6155884887

Economic growth is often examined in the economic literature. Nevertheless, from time to time, new, thought-provoking approaches are used. This is what happened in 'Fully Grown', a book by Dietrich Vollrath. The author discusses a topical issue as he searches for the reasons for the slowdown in economic growth, examining its components one by one. The professionally sound analysis is complemented with the careful use of statistical data and the vivid presentation of economic concepts, while remaining within a relatively simple methodological framework. This helps the author support his arguments with examples that are easy to understand and follow, described in accessible language. According to one of the main conclusions, the slowdown in economic growth is partly attributable to the success in raising living standards. This is supported by a well-reasoned argument.

In the wake of the global financial crisis, the growth rate of the US economy plunged to less than half of the average in the earlier decades. Annual GDP growth averaged 2.25 per cent between 1950 and 2000, after which the average growth rate declined to 1 per cent. This slowdown was characteristic of many advanced economies. Although living standards in the USA continued to rise, an even higher level could have been achieved had economic growth not faltered. From the perspective of the factors of production, physical capital explains only a small part of this process. The expansion in physical capital declined much earlier, in the 1970s. The fairly muted economic growth was basically due to the development of human capital and productivity, and therefore the author takes a closer look at these two factors.

* 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 slower growth in human capital explains a major part of the economic slowdown. In terms of the components of human capital, the impact of its size is far greater than education, experience or hours worked. In particular, there were two dominant aspects within the size of human capital. One of them, the ageing of society, was clearly reflected in the shrinking share of the working age population within the total. Even though the population continued to increase, the number of elderly also rose considerably, partly on account of longer life expectancy. The other effect, the fall in the fertility rate, is linked to rising living standards. Based on data from almost two hundred years from the United States, income and fertility are negatively correlated. In addition to analysing economic developments, the author also points out that in advanced economies the size of the remaining labour reserves is questionable.

Just like with human capital, any slowdown in productivity (which is not the same as technology) growth has a detectable effect. The author refutes the usual explanations (statistical or measurement errors, increasingly costly innovations), and demonstrates that most of the slowdown can be attributed to the shift in consumption patterns towards services. In itself, this process points towards moderate growth in productivity, because productivity in the service sectors typically increases more slowly than in manufacturing. This constraint arises from the nature of services, because if firms devote less time and attention to consumers, the demand for their services declines. The share of spending on services started to climb in the mid-20th century, but the economic weight of services had increased so much by the 21st century that the slower growth in productivity became apparent throughout the entire economy.

To a smaller extent, the rise in market power and the less dynamic adjustment of the economy may also have played a part in this. Companies' market power drives innovation on the one hand, because the advantage derived from patents compensates them for the resources necessary for innovation. Nevertheless, too much market power can be a double-edged sword. Stronger concentration is reflected in a drop in investments, since companies have fewer incentives for innovation when competition is muted. At the same time, this can also reflect the shift in consumption towards the firms with higher market power, which shows that the development of economic data can be attributable to various factors. Looking ahead, a shortfall in investments can lead to fewer innovations and thus slower productivity growth. It can also be observed that the flow of labour between different jobs and production locations has decelerated compared to earlier decades, and there are also fewer new and closing businesses. Moreover, geographical mobility has also declined, which may reflect a change in preferences or rising housing costs in certain areas. All of this provides fewer opportunities to

improve productivity. Establishments are taken over by more productive firms less and less frequently, and fewer and fewer workers switch to higher-productivity jobs.

With other factors, the impact on economic growth seems negligible. The author shows that even though changes in taxation and regulation and inequalities can have considerable distributional effects, these are not the factors that determine the slowdown in economic growth, just as no major impact can be detected in connection with trade with China. It seems that taxes and regulations have no marked effect on economic growth, which may be because the markup and the scale are more important for firms' profits. The change in income inequalities is also often cited as a reason behind the slowdown in growth. In the lower part of income distribution, people can invest less in education due to their stagnant income, which limits the growth in human capital, and the greater concentration of incomes may have accelerated the shift towards services. Finally, it should be noted that China became a full member of the World Trade Organization (WTO) in 2001. Research has shown that Chinese imports have significantly reduced employment in the US manufacturing industry, which may have contributed to the deceleration in economic growth. However, these effects all seem too small to have any major explanatory power.

The author identifies the less dynamic expansion in human capital and moderate productivity growth as the main reasons behind the slowdown. According to the results, the slowdown in economic growth is mostly linked to the shrinking size of families and the ageing of society. Together with the shift towards services in consumption, this accounts for approximately three quarters of the slowdown. The author views these as two success factors arising from growing prosperity, the result of a conscious decision. The fertility rate declines as living standards rise. The change in consumption patterns is also the result of the success in increasing prosperity. As product prices fall and the necessary quantities are purchased, consumption turns towards services, while the productivity of service sectors is relatively lower.

If certain factors can be considered successes, the author believes that people should ask themselves what they are prepared to forgo for faster growth. Would they sacrifice some of their living standards for faster population growth? The impact of technological progress (3D printing, artificial intelligence) is also not straightforward: the production of goods is becoming more efficient, but the shift towards services is accelerating, which may further check productivity and thus also economic growth. According to the book's approach, moderate growth is the result of the success in increasing prosperity, as society adjusted to the higher living

standards. This also limits the opportunities for accelerating growth in the future. However, success does not mean that the results cannot be improved any further. Growth may continue to fall short of the rate seen in the 20th century, but the ways to ensure sustainable economic growth also have to be explored. However, this will have to be done in another book.

Between the Trauma of Trianon and Today: Thoughts on the *Economic History of Hungary for the Last 100 Years**

György Kocziszky

Barnabás Virág (ed.):
Trianon 100 – Tízszer tíz év számokban – Magyarország elmúlt 100 évének gazdaságtörténete.
(*Trianon 100 – 10 x 10 Years in Numbers – The Economic History of Hungary for the Last 100 Years.*)
Magyar Nemzeti Bank, Budapest, 2020., p. 336
ISBN: 978-615-5318-37-5

In the Year of Unity, the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB) could hardly have commemorated the anniversary of the signing of the imposed Treaty of Trianon in a more appropriate and elegant manner than with a perceptive and analytical account of the events determining the course of economic history in the past ten periods of ten years.

Providing a cross-section of the economic history of one hundred years (especially these "long" one hundred years) is an enormous challenge, all the more so because many of the politically motivated explanations from the past decades (together with their "anointed" proponents) still live on, often painting an inaccurate and distorted picture of specific periods or decades.

The book truly fills a huge gap. Here, it must be pointed out that this is not simply the usual and "obligatory" formality found in reviews. Lamentably, economics courses at Hungarian universities and doctoral schools no longer include economic history, even though future generations could learn much from the virtues and mistakes of past economic and monetary policymakers.

It is therefore appropriate to say that the editor (Barnabás Virág) and the company of authors (Gergely Baksay, Judith Balázs, Pál Pozsonyi, Antónia Hüttl, Gábor P. Kiss, Béla Simon, Gábor Dániel Soós, Eszter Szabó, Katalin Szőke) have produced

* 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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something that has been severely lacking. A quick glance at the telling chapter titles only reinforces this impression: *The reviving economy of the truncated country: the 1920s. Global crisis and stabilisation: the 1930s. Global conflagration and reconstruction: the 1940s. The liquidation of private economy and the trauma of the Revolution: the 1950s. The evolution of goulash communism: the 1960s. Oil price shock and indebtedness: the 1970s. Lack of turnaround and reform: the 1980s. Free again: the 1990s. From Vanguard to Bringing Up the Rear: the 2000s. The era of balance and growth: the 2010s.*

Somewhat arbitrarily and hopefully fittingly, the reviewer summarises the conclusions based on the chapters evaluating the economic history of the past one hundred years.

1. Dividing the past one hundred years into ten times ten years was a wise choice. The balance position of these decades was influenced by utterly different geopolitical and ideological factors and power constellations. No wonder that the results are also markedly different.

2. All of the authors analyse the reasons for the success or failure of the decade they examine. We can almost certainly conclude that those (unfortunately few) periods were successful during which economic and social policy served the nation's interests. It should be borne in mind that in the successful periods, economic policymakers and economists who were recognised at the European level (e.g. Sándor Popovics, Tivadar Surányi-Unger, Elemér Hantos, Farkas Heller, Ákos Navratil) led the way: their works on monetary policy, the general government, prosperity, the dangers of income inequalities or the large-space economics of the countries along the Danube are still relevant today, in several respects.

3. The failure of economic policies in the past decades was largely influenced by serving foreign political interests and ideologies: policymakers did not tolerate those who voiced their independent, divergent opinions, and such people were killed, undermined or forced into exile. They include several outstanding economists and social scientists (e.g. Sándor Lámfalussy, István Muzslay, Miklós Káldor, Tamás Balogh, Béla Balassa, Tibor Scitovszky). These luminaries were replaced by epigones regurgitating the mainstream ideas imposed on Hungary, who were unable or unwilling to break free from the conceptual shackles forced on them.

4. The authors convincingly show that the witches' brew of reforms targeting the operation of the economy and economic restructuring failed in the early 1970s. This led to economic stagnation. Driven by cold political calculation, politicians turned towards foreign lenders to manage social tensions, and the Hungarian

economy embarked on a path leading to indebtedness arising from sustained imbalances.

One lesson to take to heart is that if fiscal expansion does not contribute to the economy's efficiency and competitiveness, market coordination, the careful management of state assets, and the restructuring that becomes necessary from time to time, then the budget deficit and government debt may increase so much that the burden will be borne by future generations for decades.

5. Economic growth cannot be sustained without balance. After the geopolitical turning point in 1989, the crisis of transition was overcome in a relatively short time, but the government at that time chose balance over economic growth after considering the trade-off between the two.

6. An important lesson from the studies in the book is that curbing investments and consumption pushes the economy into a negative spiral due to budget cuts, which has dire social consequences.

7. In the years around the turn of the millennium, Hungary pressed ahead in terms of economic figures in the Central and Eastern European region, but on account of the mid-2000 financing turnaround, the state and households could only maintain economic growth by borrowing, which led to high twin deficits in the budget and the current account and a surge in external debt. As a result, economic growth ground to a halt after 2006, and global financial crisis of 2008–2009 hit Hungary in a vulnerable position. The most serious structural issues included low employment figures and FX indebtedness in the context of muted investment activity.

8. The new economic policy launched in 2010 and the monetary policy after 2013 put Hungary on a convergence path once again. The initially widely lambasted unconventional economic policy increasingly became accepted globally, because it proved to be effective. The budget's position improved, and this paved the way for the turnaround in growth.

   Transformation of the tax system began, the turnaround in the labour market started, and with it, new incentives went into effect in the labour market, contributing to the creation of hundreds of thousands of new jobs in the following years. Meanwhile, internal and external balance were restored, and government debt relative to GDP was put on a sustainable downward path.

   The author of the chapter examining the period is right to note that: *"the re-expansion of retail lending took place in a healthy structure, and the introduction of macroprudential rules provided additional stability for the sustainable functioning of the country. Due to the general economic recovery, the reduction*

of previous debts, the constantly improving labour market situation and the restoration of general confidence, a turnaround in investment and growth unfolded from 2013 onwards."

The experience of the 2010s clearly demonstrates that *harmony between the branches of economic policy can restore financial balance.* This is attributable to the structural reforms that were carried out to complement the fiscal and monetary policy measures. The strategy based on this has successfully stabilised Hungary, putting it back on a sustainable convergence path.

9. Thanks to the editor's and the authors' meticulous, accurate and professionally appropriate work, the book is not a mere collection of bombastic proclamations. It encourages readers to think and reflect on the topics, in which the statistics at the end are of immense help.

10. The elegance in the printing, the book's collection of figures and tables are worthy of the Magyar Nemzeti Bank's mission, and the gravity and detailed presentation of the issue.

Based on the above, the reviewer recommends the book not only to the narrower group of professionals but to anyone who wishes to have firm and credible reference points for understanding the intricacies of economic policies from the past decades.

How Can a State Become Sustainable? – Thoughts on Understanding One of the Key Challenges of the 21st Century*

Nóra Anna Sándor

Chandran Nair:
The Sustainable State – The Future of Government, Economy, and Society
Berrett-Koehler Publishers, Oakland, 2018, p. 252
ISBN: 978-1-523-0-9541-8

Chandran Nair is the founder and CEO of the Global Institute for Tomorrow, an independent Pan-Asian think tank. He is a member of the Club Rome and served as chairman of Environmental Resources Management in Asia Pacific. The author is a regular speaker at events of the World Economic Forum, Asia-Pacific Economic Cooperation Summits, and Organisation for Economic Co-operation and Development.

According to Nair, the current economic model based on *consumption, growth* and a *free market* system has clearly caused an ecological and social disaster for the developing world. His book emphasises *the importance of strong state engagement*, in contrast to the Western '*laissez-faire'* economic development model, which is regarded as unsustainable. The author argues that balanced development is only possible when the state shapes economic policy efficiently and with a strong hand, paying special attention to environmental protection and citizens' most basic needs. However, this calls for revisiting concepts such as *prosperity, freedom* and *rights.* Therefore, strong state institutions are vital for a sustainable future.

The author starts the book by explaining some concepts, which is necessary as the definition of *'sustainable development'* is often reduced to simply cutting pollution, leading an environmentally friendly life and being environmentally conscious. But environmental awareness is not a synonym for sustainability. *Sustainability means that a system can sustain itself indefinitely, using only the resources that can be reproduced.* A more sustainable economy means that the gap between producing resources and the environment's capacity to replenish them is narrowed. Some

* 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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allegedly green technologies are environmentally friendly, but do not narrow this gap. In other words: *'all sustainable systems are green, but not all green systems are sustainable.' Development* refers to ensuring that a population's basic needs are met (clean water, food security, access to the healthcare system, energy security) and improving living standards. An advanced economy can provide this to citizens, and developing countries seek to achieve these goals. Consequently, *sustainable development* means raising living standards without producing, or overconsuming, resources faster than they are reproduced.

In this work, Chandran Nair seeks to find solutions to issues such as the so-called *'India question':* how can a country of 1.2 billion people lift millions out of poverty over the next 30 years while reducing its emissions and resource use? This is the greatest dilemma of sustainable development. Nair believes that change can only come if the leaders of richer countries adopt a *new political philosophy* centred around collective prosperity, rather than ensuring individual rights on the one hand and reinterpreting the concept of prosperity on the other hand. Despite their rhetoric, the leaders of the Western world strive to maintain the status quo, increase their power and ensure growth. Sustainable development has to be about 'less' rather than 'more', but companies have always targeted profits. If the developing world truly wishes to be sustainable, radical changes are necessary: the economic model based on the free market, the free flow of capital and the Western development pattern should be reconsidered.

The book consists of twelve chapters that build on each other while presenting the main challenges and issues with a sustainable future, illustrated by examples. Chapter 1 defines the concepts used throughout the book, including sustainability, development, social responsibility or greening companies. Chapter 2 highlights the dichotomy of sustainable development: promoting development while taking into account sustainability considerations. The author argues that the free market is unsustainable for three reasons: the first comprises the negative externalities, which are not incorporated into product prices; the second is the *'tragedy of the commons';* and the third can be explained by the term *'power gap',* which refers to some interest groups becoming richer due to overconsumption, while others become poorer. Chapter 3 points out the incompatibility of conventional economic policy and sustainable development: the author claims that market mechanisms alone cannot ensure sustainable development. Precisely because of this, the focus should be on the *'state's visible hand'* rather than the *'market's invisible hand',* and this would put the economy on a more sustainable footing; in other words the author believes that the key to a sustainable future is the establishment of a strong state.

Chapter 4 shows why – instead of international organisations, agreements or local governments – it is the state that plays a crucial role in ensuring sustainability. The

state is the only entity that has the necessary power, accountability and legitimacy to formulate and implement economic policy. No governmental unit at any lower level is able to make complex decisions in important issues such as sustainable development, nor do they have the necessary institutional background.

In Chapter 5, the author lists the three main objectives of a sustainable state, namely the protection of public goods, creating *'moderate prosperity'* and ensuring social progress while taking into account the scarcity of resources. Nair maintains that developing states should not focus on providing high growth but on formulating policies that contribute to development while ensuring equality. In Chapter 6, the author considers it important to explain why the concept of a *'strong state'* and democracy should be distinguished. He emphasises that by strong state he is not referring to a totalitarian regime. A strong state means an entity that is able and willing to take action for the prosperity of its citizens, while also being appropriately accountable.

The following chapter examines the concept of *checks and balances,* and how this is applied in the different political systems, highlighting the factors that arise from 21st-century trends which strong states need to address. Examples include the fact that in today's world of scarce resources, the state's role expands, and it will be forced to intervene more in people's everyday lives than ever before in history. This requires a strong institutional system and the optimal operation of the checks and balances. In Chapter 8, Nair proposes revisiting concepts such as freedom, rights and prosperity. In order to ensure sustainable development, their traditional interpretation must be redefined. The author also provides an alternative to these concepts, which – he argues – could also serve as the foundation for the sustainable economic model of the 21st century.

The last third of the book calls attention to the most important environmental issues of our age. In Chapter 9, entitled '*The Tropical Haze Crisis',* the author uses examples to illustrate what happens if we continue to live in this unsustainable manner. It will inevitably lead to constant pollution, tropical forest fires and the shrinking of arable land, due to unsustainable agricultural practices. In the chapter called '*The Tropical City is no Paradise',* Nair collects problems that are all the result of the present unsustainable development. These can partly be attributed to growing urbanisation and its negative impact (e.g. traffic jams). Nair argues that urbanisation is a typical example of the issues related to sustainable development that the strong state needs to address.

He takes a look at China in Chapter 11, presenting how a strong state, in this case the Asian country, can achieve great success in issues such as eliminating poverty and the fight against climate change. Although China is on the right track, and in Nair's opinion it can serve as a future model state, it still has some way to go. The last

chapter, Chapter 12, outlines how a state can enter the path towards sustainability, listing the requirements for that. The basic foundation of a strong state with long-term sustainability is the establishment of a new political and economic philosophy, in which decision-making is inspired by the concept of sustainability.

This book, published in 2018, is in keeping with Nair's former work. In his first book published in 2011 ('*Consumptionomics: Asia's Role in Reshaping Capitalism and Saving the Planet'*), he already mentioned the issues discussed in *'The Sustainable State',* but the former mainly focuses on Asia, and the problems related to sustainability are primarily examined from the perspective of consumption. By contrast, *'The Sustainable State'* attempts to present the perhaps greatest challenge of the 21st century: the achievement of sustainable development, in three dimensions. The book points out questions related to the *state, society* and the *economy,* before ultimately concluding that *only a strong state will be able to provide a solution for sustainability.*

'*The Sustainable State: The Future of Government, Economy, and Society'* can be useful for understanding the various dimensions of the academic discourse on sustainability, and therefore I wholeheartedly recommend it to all experts, researchers and teachers engaged in economics, finance or social sciences who deal with the future of economics, sustainability and various issues of public policy in their work. Outside the academic world, the book may also be an interesting read for those who would like to learn more about sustainability's different aspects.

The Code of Capital*

Katalin Botos

Katharina Pistor:
The Code of Capital: How the Law Creates Wealth and Inequality
Princeton University Press, 2019, p. 297
ISBN: 9780691178974

Katharina Pistor's book, which was rated one of the best publications by the Financial Times in 2019, is an interdisciplinary study. The author – currently a professor at Columbia University – received her initial education in Munich, Hamburg and Freiburg and obtained her LLM qualification in London. Although a legal expert, she wrote her work on important economic issues. According to her, *with the correct legal "coding",* any object, idea or claim *can be turned into capital,* which is then guaranteed to someone by the law protecting private property. It becomes capital in the sense that, based solely on ownership, income can be generated for the owner of a given asset in the future.

The code of capital can essentially only be enforced with the help of power, in the legal order guaranteed by it. Ownership is based on state law, but "coding" can also be a "private action", because legislation is often the result of effective lobbying. The *code of capital* can be put into practice via the legal system and institutions of the state. Legal guarantees ensure the sanctity of private property. In addition, the law can guarantee even more: for example, to protect a given asset from the claims of others against the owner, e.g. in the form of a trust, or to receive a more favourable assessment in the event of bankruptcy (e.g. for derivatives).

In Eastern Europe, generations of economists have been raised with the tools of Marxian analysis. According to this, capital is a *means of production* that – through the exploitation of labour – brings extra income to its owner. According to Marxian theory, only work creates new value. Thus, since workers receive only a fraction of the value produced, the owners of the means of production – as Marxism puts it – actually deprive workers of the value they have created.

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* 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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Employees are undoubtedly in a vulnerable position compared to the owners of the means of production. To this extent, there is definitely a labour-capital contrast. Workers are forced to take jobs to make a living. True, capitalists need them, but their bargaining positions are not the same. The owner of a means of production does not die of hunger tomorrow if he/she cannot find an employee... But for workers, wages provide a livelihood. The owner was in a more advantageous position even when strikes were possible during the time of organised labour and so they could put pressure on employers (one need but think of the months-long miners' strike in England, where the workers were ultimately forced to concede when the strike coffer was completely depleted).

(Money) capital, with which the means of production are bought, and thus the connection with work becomes possible, is *money-generating money.* Ultimately, legislation makes it what it is; this is what makes it suitable for income *appropriation.* Capital has never been *just a thing,* not even in pre-capitalist times: it has always been a kind of legal *relationship,* the enabling of the ability to acquire future income.

In contrast to Marx's theory of labour value, bourgeois economic theory insists on a certain "equalisation" of labour and capital, and says that the market mechanism ensures that every factor receives "its fair share". The capitalist has a means of production, whereas the worker has labour: cooperation between the two is the source of value production. Accordingly, therefore, there is no exploitation at all, only a mechanism acting by the force of natural law (which – by the way – is mediated by the *law,* in this case by contractual rights). However, there is no mention of what guarantees the fairness of distribution. In the managerial capitalism of our time, astronomical incomes are also regarded as wages, but such incomes are certainly not related to the actual performance of the persons concerned. A manager's income that is 750,000 times (!) higher than the average wages – as cited by Raghuram Rajan[1] – must certainly be considered unrealistic. Such a difference in work performance is practically impossible. Such astonishing magnitudes have never been known before anywhere – neither in England nor in Japan. There has been a maximum tenfold or up to thirtyfold difference between managerial and average wages. Obviously, in the life of a company, a lot depends on the quality of the manager. However, not *so much* by any means... Of course, it can be legal. It can be sanctified by corporate law and the labour code. Managerial "wages" are a function of the advocacy skills of the number one company manager (e.g. in a huge joint-stock company where absolute figures are relativised). Here, in fact, it is no longer the owner who shares with the employee, but the manager who dictates.[2] Who gets how much of the value created? Nowadays, an average employee usually has no serious advocacy opportunity at all, especially as the role

[1] *Fault Lines*. Princeton University Press, 2010.
[2] See Galbraith, J.K.: *Az új ipari állam (The New Industrial State).* Közgazdasági és Jogi Könyvkiadó, 1970.

of trade unions has diminished. In fact, workers in the market are vulnerable to the arbitrariness of managers and to market conditions, and now to *global* market conditions. It should be noted that when a person creates a corporate form to sell his/her work and pays himself/herself a dividend instead of a wage, the difference between wage and profit is completely blurred (this decision is influenced by which form requires less to be paid into the state coffer, and this aspect can play a role for both the employee and the employer).

First and foremost, however, it needs to be defined *what can be actually considered a capital good.* This is because capital goods do not necessarily have to be a *"means of production"* in the traditional sense. In the sense that the owned asset, or legal relationship (!) *produces money,* of course, they are. Nevertheless, it does not necessarily have to be involved in the production of *material goods.*

The concept of capital is thus an important category for distribution theory. How can the owner of a capital good receive income? And how much? *The Code of Capital* also tries to answer this question, as the author not only points to the question of *how* the coding of capital has resulted in *income disparities* today, but also to how great these *income disparities* are.

The author begins with a historical review. For centuries, land was the most important means of production. Its *ownership regulation* ensured that it would yield a return to its holder. Pistor provides an extended analysis of land ownership in ancient times, including the ways and means by which New World settlers acquired private ownership of land in America.

Today, the scope of the means of production has expanded. In our modern age, in addition to physical capital, real estate, land, machinery or intangible assets, things such as patents, royalties and brand names can become capital. What makes the issue of coding particularly exciting is that there are many different ways and means by which the law can *turn* debts, complex financial products and other assets (relationships) *into capital,* which thus provide financial benefits to their owners. The process of financial innovations and securitisation is also a phenomenon that generates intangible assets. Receivables-backed securities can be traded and income can be "produced" with them. Thus, money is "created" from a claim. Owning specific *datasets* can also become capital, as we can see today.

With captivating personal examples, the author illustrates how many things the law can turn into capital. She presents the story of Angelina Jolie, in which the celebrity had to undergo a mastectomy. She was genetically at high risk of developing breast cancer and its complications. The genetic testing option, on the basis of which this was established, was the result of a great deal of state-funded research. However, one company patented a specific process and then monopolised the market and

charged a high price for the service. While tests performed before the patent (according to processes based on state research) cost $100, after the patenting procedure, they cost as much as $3,000. It was not the company's intellectual product that actually had to be paid for by the user but one of the *nature-related laws* learned at public expense. We can see – as the author refers to it – that, by patenting, even from nature it is possible to make private capital as a source of money!

An exciting part of the book is when the author deals specifically with the analysis of the "coders", the *lawyers* and the legal systems. She points to the special power of trained lawyers. She also shows the difference between the Anglo-Saxon-type *common law* based on legal precedents and the private law stemming from Roman law, the *civil law* in force on the European continent. The Anglo-Saxon model provides a way for private lawyers to create new rights. In fact, the only limitation on this is the judge. It is up to the judge to decide whether to accept the client's position. However, in the US and England judges themselves come from the (private) lawyers faculty, so this is usually not a major obstacle for lawyers to overcome in succeeding with their cases.

In Continental law, the distinction between private law and public law is much stronger, because – as Pistor writes – in legal training, there is a separate preparation in terms of whether someone wishes to become a judge, a prosecutor or a lawyer.

One of the author's most important findings is that in modern international practice, the "pathways" between legal orders are relatively large. In the area of contract and corporate law, this process has already advanced quite far (for example, this allowed Lehman Brothers bank, which played a significant role in triggering the 2008 crisis, to set up hundreds of subsidiaries in the legal systems of different countries, companies which did not even carry out any activity or conduct any transactions). Harmonising the legal order of each country is a very slow and difficult process. As a solution, partners had the opportunity to choose under which country's law they would like to conduct their transaction.

Today, it is possible to choose *which country's legal order is applied* by private parties to an action. This is a particularly important development in the area of finance. Besides, territorial control is of little use for capital goods that lack physical form or location. This is made possible by *agreements that eliminate conflicts* between countries. As a result, New York State law and the English legal procedure became the key factor in most operations.

The ISDA (International Swaps and Derivatives Association) was formed in 1985. Without its activities, it would not have been possible to establish the global derivatives market, which operates through the financial centres of New York,

London and Tokyo (this, in turn, was the main cause of instability in the financial system). The ISDA is the most influential private organisation that creates *codes of capital* in global finance. In the case of derivatives, the Hague Conference on Private International Law established an international treaty that standardised conflict-of-law rules for financial assets. Those rules, in turn, are determined by private parties, as we have seen.

Due to the advanced standardisation, derivative amounts in the billions can also be traded over the counter (OTC). At the same time, the ISDA has managed to get some 50 countries to bring their national legislation in line with private contracts. According to this, the legal order in which the issuance took place is relevant for the ownership of the assets as well. This, too, reinforced the generalisation of English and New York State practices.

Bankruptcy law today is still essentially a national competence. To date, however, bankruptcy proceeding has not been settled for internationally active banks (the EU has recently attempted to develop a common set of rules for the banks of *the member states of the euro area;* however, other countries do not yet have such regulation). With the aforementioned agreements, most derivatives were essentially withdrawn from bankruptcy proceeding.

Patent law is, in principle, also in the hands of sovereign states. Although states have already moved towards harmonisation in the field of intellectual property rights, many detailed rules are still tied to individual states. At the same time, by concluding bilateral *investment treaties,* they have let quite a few areas go from their hands. The so-called ISDS (Investor-State Dispute Settlement), *a treaty for settling disputes between investors and the state,* has been established. Accordingly, it is permissible to submit the settlement of disputes to arbitral tribunals outside the territory of the host country. During these proceedings, the host country may also be ordered to pay damages on the basis of unfair treatment. Such an example is given by Pistor in the case of the Eli Lilly company, a patent registration of which was not accepted in Canada. According to the Canadian law, despite some changes, the renewed patent did not bring about a significant extra value compared to the original one, so it was not accepted by the Canadian authority. Referring to the investment treaty, the company challenged the decision, and demanded compensation. This led to a veritable war between the company and the Canadian state over the issue. The battle was eventually won by the Canadian state after very long litigation. In Pistor's view, the war has not yet been won... A state with less financial resources may not be able to go through this high-cost series of lawsuits. In other words, it is still not clear who is actually entitled to determine ownership, i.e. to code capital: private agents or the sovereign state.

Report on the Online 'Lámfalussy Lectures Conference' Held in January 2021*

Ferenc Tóth

The Lámfalussy Lectures Conference – the most significant international event organised by the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB), named after Alexandre Lámfalussy, the Hungarian-born economist and renowned European finance expert – was held for the eighth time on 25 January 2021, in an online format for the first time in its history with regard to the epidemic situation. The topic of the event was „The future of monetary policy after Covid-19 with a perspective for public debt evolution". The Lámfalussy Award and Popovics Award were presented during the conference.

In his opening remarks, *Barnabás Virág*, Deputy Governor of the Magyar Nemzeti Bank, noted that the Covid-19 epidemic had caused unprecedented economic and social disruption around the world. Several countries had experienced a decline in economic activities and been forced to impose strict lockdowns to curb the spread of the virus. The epidemic posed serious challenges for policymakers. To reduce the negative economic impact, fiscal and monetary authorities implemented large-scale measures such as job protection schemes and government securities purchase programmes to support the economy. The Covid-19 crisis changed the way the world operates with potential shifts that will outlasts the epidemic. In three main points, the Deputy Governor of the MNB summarised what central banks will look like in the future after the crisis caused by Covid-19: (1) There will be closer co-operation between fiscal and monetary policies. An optimal policy mix can only be achieved through continuous communication and cooperation between different branches of economic policy. In Hungary, for instance, the government introduced tax breaks and job protection measures to alleviate the situation of businesses and employees as the pandemic erupted, and simultaneously the MNB took a number of targeted, coordinated measures to provide the required amount of liquidity to all economic agents. As a result of the measures, no financial turmoil emerged at any point in any submarket. (2) The second feature is the expansion of central banks' balance sheets. Support for economic growth coincides with a dynamic increase in the balance sheets of central banks. Central bank balance sheets expanded to record levels due to asset purchases and other liquidity providing measures. In Western

* 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, this was rather necessary to secure stable financing of public budgets due to extraordinary measures taken by governments. By contrast, for Central and Eastern European central banks, this was more of an opportunity to support governments in crisis management. Between 2013 and 2019, the MNB maintained its monetary policy room for manoeuvre by keeping the size of its balance sheet low compared to many other central banks. This allowed the MNB to launch its government securities purchase programme in order to maintain a stable liquidity position in the government securities market and strengthen the effectiveness of monetary policy transmission. (3) The continued presence in the government securities market will mean a larger central bank balance sheet, which will be the new norm in the future. However, the objective of government securities purchase programmes is not to finance budget deficits, but rather to ensure the smooth functioning of the government bond market. This will improve monetary transmission, which in turn will contribute to the MNB's primary objective of price stability and keeping long-term interest rates relatively low. Central banks can also promote sustainability in two areas, by supporting green financing and digitalisation. In both cases, the MNB intends to play a pioneering role. He then indicated that there is a need for targeted money creation to address the most pressing challenges of the 21st century. This is more sustainable than general money creation and can ensure financial stability in a broader sense. Debt always remains debt, while deficits always become debt. The winners of the next decade will be those who draw the right conclusions and find creative, wise and courageous new solutions.

This was followed by the award ceremony of the Lámfalussy and Popovics Awards, as the Lámfalussy Gala, which traditionally preceded the conference, did not take place due to the pandemic situation. The Lámfalussy Award is bestowed on internationally outstanding professionals who exercise significant influence on monetary policy. This year, this prize was awarded to *Boris Vujčić*, Governor of the Croatian National Bank (CNB), who was a member of the Steering Committee of the European Systemic Risk Board, a member of the Financial Advisory Committee of the Federal Reserve Bank of Atlanta, a member of the Board of the Global Development Network and has been Chairman of the Steering Committee of the Second Vienna Initiative since October 2016. Mr Vujčić has played a key role in Croatia's accession to the European Union, in the reform of Croatia's monetary policy instruments and in keeping the kuna (the Croatian currency) stable, which has helped to bring the country to the brink of adopting the euro. The Popovics Award, named after the first Governor of the MNB, rewards outstanding professional work in the field of economics and finance. This year, *Gergely Fábián*, Executive Director of the MNB's Financial System Analysis and Statistics and CEO of the Budapest Institute of Banking, received the Popovics Award.

The topic of *Boris Vujčić's* award recipient speech was non-traditional monetary policy in emerging countries. He explained that central banks were expected to respond to almost all problems these days: achieving inflation targets and addressing the lack of economic growth or credit, even inequality and environmental protection issues, or now, for example, in Croatia, dealing with the consequences of the earthquake. Looking back at interest rate developments in recent years, few would have thought that a negative interest rate environment would be more than a temporary phenomenon in economies. Today, however, extremely low interest rates seem to remain a constant feature of the economy. Recent research suggests that the downward trend in interest rates spans a much longer period, at least seven centuries. Falling interest rates seem to predate even the establishment of the first central banks. Over time, the frequency at which negative real rates appeared has increased, and that happened regardless of the dominant monetary regime such as fiat money issued by a central bank, or some form of species monetary standard such as gold or silver. It is an interesting twist of fate that it is the reduction of investments, as population growth slowed and the nature of technology changed, that is pushing interest rates down, rather than an increase in savings. Savings rates have remained robust due to the rising "rich savings glut", rather than due to any increase in general living standards. In addition, a growing portion of the world's surplus savings are generated by Far Eastern economies, with capital flowing towards richer economies. Furthermore, the impact of low interest rates on inequality is far from straightforward. Various channels work in different ways and many blame them for the increase in inequality, especially the inequality in wealth. Low interest rates interact with the economy in a complex way, with some evidence of its negative impacts on productivity growth, commonly known as the "zombification of the economy". Due to the problem of the lower bound on policy rates, in the major advanced economies, central banks pursued asset purchase policies in the context of quantitative easing and forward-looking guidance. Until recently, such policies were definitely limited to a small number of large central banks that issue reserve currencies. However, since the Covid-19 crisis, some 20 emerging market central banks have launched asset purchase programmes. Such policies have reduced bond yields and improved financing conditions for the domestic economy. In emerging economies, the main objectives of asset purchase programmes are much more related to stabilising markets and less to pushing up inflation. Last year, the Croatian National Bank conducted one of the largest asset purchases among the emerging economies, accounting for about 5.5 per cent of GDP. Although the CNB did not opt for the purchase of domestic securities, but rather for the accumulation of international reserves, the bank's liquidity channel operated in the same way. The foreign exchange swap agreement with the European Central Bank (ECB) and subsequent accession to ERM-II have also contributed to the stabilisation of markets and the success of the asset purchases. Asset purchases used so far in emerging economies do not appear to generate major risks to the

domestic economy. At the same time, the unconventional policies of major central banks, which drive capital flows and credit cycles at the global level, are likely to continue to be an immediate source of risk to the financial stability of emerging economies.

Subsequently, *Yi Gang*, Governor of the People's Bank of China (PBOC), gave a keynote speech. The Covid-19 pandemic left its mark on the last year. The PBOC took a number of measures to give a strong impetus to the economic recovery, with the objective of stabilising employment. In China, most workers are employed in the private sector, especially at SMEs. Therefore, the PBOC has – via its credit policy – encouraged commercial banks to increase their funding to micro and small enterprises. Two loan instruments were introduced to support micro and small enterprises, with deferred loan repayments and preferential borrowing facilities without collateral. By the end of last year, banks had provided about USD 1,000 billion in deferred capital and interest rebates, and micro and small businesses had received soft loans worth about USD 500 billion. This provided support for more than 31 million businesses entities. Lending decisions are made by commercial banks, as they are responsible for the credit risk, but the PBOC provides some incentive tools. Banks that provide loans for at least six months are eligible for a lump sum subsidy equal to 1 per cent of the principal, and the PBOC provides refinancing up to 40 per cent at zero interest rate for those lending without collateral. The base rate was reduced by 50 basis points last year, while the 10-year government bond yield is about 3.1 per cent, the overnight repo rate is less than 2 per cent and the consumer price index is currently about 2.5 per cent. The RMB exchange rate is at USD/RMB 6.5, having appreciated by around 7 per cent versus USD last year. Monetary policy will continue to adjust to new economic developments in a timely manner, but will strike a balance between stabilising economic growth and preventing risks. The PBOC will keep the growth rate of money supply in line with the nominal GDP growth rate. The PBOC will use its two monetary instruments this year, as well. In this way, it helps and encourages banks to use their loans to support the development of the real economy, especially agriculture, as well as micro and small enterprises and private businesses. President Xi Jinping announced that China would reach its peak carbon emissions before 2030 and become a carbon-neutral economy before 2060. Therefore, the PBOC is focusing on promoting the development of green finance. In China, green loans worth USD 1.7 trillion were issued, ranked first globally. In addition, more than USD 154 billion worth of green bonds were issued, making China the second largest green bond market in the world. In order to achieve the green goals, the 5 pillars of the green financial system need to be further improved:

1. the system of green financial standards,

2. the supervision of financial institutions and disclosure requirements for green finance related information,

3. on the regulatory side, financial institutions should be encouraged to provide soft loans by reducing CO_2 emissions,

4. continuing to develop products such as green credits, green bonds and green funds. A carbon market and a market for green futures need to be developed, and

5. strengthening international cooperation in green financial standards, and in particular the finalisation of the China-EU common ground taxonomy as soon as possible.

The next part of the conference was the panel discussion, moderated by *György Szapáry*, Chief Adviser to the Governor of the MNB, on the topic of the future of monetary policy in the post-coronavirus epidemic period, in particular with regard to the development of public debt. *Philip R. Lane*, Member of the Executive Board of the ECB and former Governor of the Central Bank of Ireland, *Jacques de Larosière*, former Managing Director of the IMF and former Governor of the Banque de France, *Yang Yao*, Professor at Peking University, and *William B. English*, Professor at Yale University, former Director of the Division of Monetary Affairs and Secretary to the Federal Open Market Committee, participated in the panel discussion. In his introduction, György Szapáry said that while no one questioned the need for monetary and fiscal expansion to restart economies, there is a need to look beyond the short term and think about the monetary policy framework for the coming years. He presented three charts as thought-provoking:

1. The first chart showed the balance sheets of the main central banks in terms of GDP from 2007 onwards. The two crises led to the expansion of balance sheets as central banks pumped huge amounts of money into their economies. In the case of the Fed, the Bank of England and the Bank of Japan, the central bank balance sheets as a ratio of GDP have risen up to five to six times. (In the case of the ECB, this indicator has more than tripled.) The question arises as to whether this foreshadows a resurgence of inflation.

2. The second chart presented developments in financial assets and real wages in the USA and Germany. The discrepancy is striking, as the money injected led to a rapid increase in the value of financial assets, far outpacing real wage developments. This resulted in a significant increase in income inequality. How much should central banks worry about this?

3. The third chart illustrated the rapid growth of government debt in 2007 and 2020. Can we assume that the “r-g”, i.e. the difference between real interest

rates and growth, will remain negative for a long time and that debt servicing will not be a problem?

Philip R. Lane noted that the current configuration of macroeconomic policies around the world was striking. The large-scale, but temporary nature of the global epidemic requires an oversized fiscal response that takes into account the shortfall of income for workers and companies, the asymmetric effects across industries and the need to finance extensive fiscal support over a very long period. The optimal contribution of monetary policy is to provide ample liquidity to maintain credit supply and stabilise markets, combined with an accommodative monetary stance to counter the negative pandemic shock. To achieve these goals, the ECB has developed a wide range of tools. Of these, the pandemic emergency purchase programme plays a particularly important role, given that it is expressly designed as a means of responding to the shock caused by the epidemic. Looking beyond the pandemic period, the future orientation of macroeconomic policies will face a number of challenges. The implications of low equilibrium real interest rates on fiscal and monetary policy is a key issue. It is equally important to review the conditions for fiscal sustainability and the appropriate role of fiscal policy in macroeconomic stabilisation. In relation to monetary policy, the decline in the equilibrium real interest rate is a central topic in the ongoing strategic review of the ECB.

Jacques de Larosière expressed the view that first, central banks deserve praise for their swift and massive action, as economic agents were provided with the necessary liquidity after the outbreak of the global epidemic. Thus, they managed to avoid an economic collapse, and central bankers were once again seen as heroes. Second, the former head of the IMF emphasised a critical view on the pre-pandemic loose monetary policy conditions. This resulted in indebtedness of the economies over the past 15 years. In the pre-epidemic period, adherence to the 2 per cent inflation target led to unnecessary quantitative easing. Third, with the current massive purchase programmes for sovereign securities, central banks have become *de facto* agents of fiscal policy. The long-term effects of central banks becoming quasi-direct financiers of budgets can only be seen years later. Low and excessively low levels of negative interest rates for too long have significant disadvantages in the long run, causing a liquidity trap. Great care must be taken not to jeopardise growth by setting interest rates too low. This could lead to yield hunting and the appearance of asset bubbles, weakening the stability of the financial system and increasing the chances of crises. Extremely loose central banking policies are hampering the introduction of government reform measures, discouraging long-term investors, and shifting savings toward short-term and speculative investment directions. In his opinion, the lack of inflation is misleading, since the increase in the value of

financial assets and real estate is also a kind of inflation, which in itself can lead to a crisis at any time.

Yang Yao suggested that the huge expansion of liquidity will result in a crisis and the "superfinancialisation" of the world, which will have long-term consequences. If the financial sector is to grow forever, it will require the real economy to move towards higher-yielding sectors. The link between the financial sector and the real economy is becoming weaker. This also means that the financial sector itself will become a kind of self-sustaining economy. Central banks are expanding liquidity, believing they can take it back in the future. However, historical experience says that in practice it is very difficult for central banks to reduce their expanded balance sheets, and therefore the excess liquidity will persist for a long time. One good example of this is Japan, where it will be very difficult for the government to ever repay its debt, which is close to 300 per cent of GDP. In Japan, there is virtually no inflation, and the central bank cannot use the instrument of monetary stimulus. In his view, in such a case, fiscal policy should probably play a much bigger role. In China, the monetary policy of the central bank was judged to be rather cautious, while on the other hand, the government increased spending quite aggressively. About half of last year's 2.3 per cent growth was related to public investment, while the other half was related to exports, which means fiscal policy played a significant role in recovering from the crisis.

According to *William B. English*, the Covid crisis will not change the outlook for monetary policy in the United States and other advanced economies, but it is clear that the actual lower bound will limit anti-cyclical monetary policy in the foreseeable future. This is because equilibrium real interest rates are low. Actual inflation and inflation expectations have remained stable and at equally low levels. Central banks have been successful – at least for the most part – in forecasting inflation. It is possible that inflation will rise in the future. In the future, a rise close to the inflation target would even be welcomed, but inflation expectations will probably remain low and stable. Post-epidemic monetary policy needs to focus on unconventional monetary policy, as traditional monetary policy is already limited, but it is not yet clear how effective non-traditional policy is. Many countries have already introduced unconventional instruments such as forward-looking guidelines or asset purchases, but such policies also have limitations. There are a large number of other possible programmes to encourage lending to businesses and households, such as low-cost central bank financing to encourage banks to lend more or, directly, the central bank may purchase corporate securities and thus improve financing conditions. However, these programmes are also subject to certain constraints, unless they are transformed into substantially support-only programmes, which are already more fiscal measures than monetary ones. The Fed has already made some changes to the inflation targeting system and other central banks will follow

this in the future, adjusting the monetary framework. Overall, the benefits of the new monetary policy framework need to be considered. In addition, strengthening monetary-fiscal cooperation should also be considered. It can be seen that a more active counter-cyclical fiscal policy will be needed to keep the economy on track. By maintaining low interest rates, monetary policy can continue to help provide room for fiscal manoeuvre and avoid expected crises. One important issue is the possible direct monetary financing of the budget deficit. There is a horrible experience of this from wartime. This can result in very high and persistent inflation and the situation would be worse rather than better. To avoid this, institutional arrangements may be needed to preserve central bank independence.

At the end of the conference, *Barnabás Virág* concluded that the speeches and panel discussions once again demonstrate that difficult situations inspire innovative thinking and that we can benefit from the experience of the recent period. The thoughts and ideas that were shared during the conference confirm that a new era of central banking is on the doorstep. We should take the opportunity and start building a better future now. Central banks can mainly contribute to this in three ways:

1. Closer cooperation between fiscal and monetary authorities ensures that the right policy mix is applied at all times.

2. A larger balance sheet will also enlarge the monetary policy room for manoeuvre. To mitigate the adverse financial effects of the pandemic, central banks intervened quickly and decisively. Potential negative repercussions can be handled in the same manner should further crises arise.

3. Continuous presence in the government securities market improves monetary transmission and ensures that interest rates remain persistently low. Maintaining sustainable government budgets will receive greater attention. Once economic growth is restarted, the focus needs to be shifted on restoring balance. Central banks can support the issuance of green bonds. This incentivises businesses to conduct greener practices. Implementing digital innovations can greatly improve efficiency, and central bank digital currencies might be the basis of our payment systems in the future.

In addition, a new era of thinking has begun worldwide. Events such as the Lámfalussy Lectures Conference provide a platform to share and further develop such ideas.

The entire conference can be viewed on the MNB's YouTube channel: The future of monetary policy after Covid-19 | Lámfalussy Lectures E-Conference.

Green Recovery from the Covid Pandemic – Report on the Online International Green Finance Conference in October 2020*

Renátó Ritter

Due to the Covid-19 pandemic, regulators and economic actors have found themselves in a bind. Economic growth first nosedived and subsequently returned to a protracted path of recovery. The authorities now need to focus on economic recovery, reaching inflation targets and increasing employment again. In this context, one could be rightly worried that climate-protection efforts may be relegated to the background. Promisingly, decision-makers were quick to realise that the economic shutdown is not only a bane but also a boon and that the recovery can be green, if the efforts supporting climate targets are prioritised. Held in an online format due to the Covid-19 pandemic, the international green finance conference organised by the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB) and the European Bank for Reconstruction and Development (EBRD) discussed the possibility and potential tools of a green recovery, in three sessions, with the participation of renowned Hungarian and foreign presenters.

The importance of environmental sustainability in the light of Covid-19

The full extent of the global economic downturn in the wake of the Covid-19 pandemic has not yet been fully quantified, but more and more information is available on another global issue: namely the economic, social and environmental impacts of unmanaged climate risks as well as their effects on our individual lives, according to the opening address held by *Csaba Kandrács,* Deputy Governor for financial institution supervision and consumer protection at the MNB. The Deputy Governor emphasised the importance of taking action: in this spirit, the MNB has laid down in its Environmental Strategy the gradual reduction of its own operations' emissions, targeting 80 per cent lower carbon emissions in five years. Building on the positive experiences, the MNB will continue to offset the remaining emissions by habitat restoration projects from 2020.

János Áder, the President of Hungary, the conference's chief patron, pointed out the significance of cooperation and a change in attitudes. We have to pay for the fallout

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from climate change sooner or later, either at the individual level, or, failing that, society as a whole will have to pick up the bill. The President noted that decision-makers need to realise that environmental capital needs to be quantified so that otherwise invaluable resources – such as clean air, fertile land or clean drinking water for human or industrial use – are managed in a sustainable manner.

Pavan Sukhdev, President of WWF International, expounded on why the previously mentioned change in attitudes was important. The Holocene, the current geological epoch, has provided opportunities for unprecedented rapid growth, by creating a safe and predictable environment for human civilisation (one need only think of the predictable cycle of seasons, evenly distributed precipitation or the stability of food supply, thanks to biodiversity). However, while enjoying the benefits of this spectacular development, the physical limits of the planet have been reached, which undermines the safe basis for our ascent. The lack of harmony between humans and nature has resulted in the increasing spread of diseases, and even a pandemic unparalleled for decades. The latter has had profound consequences for all our lives, which may be sufficient to make humans take into account during rebuilding the economy and our private lives what we base them on, namely the environment around us.

Assessing and managing climate and environmental risks

According to *Mattia Romani,* Managing Director of the EBRD, regulatory reforms strengthening private investments are needed to establish a competitive, well-governed, inclusive, integrated, resilient and – in particular – a green market economy. Central banks' prudential instruments should address the exponential asset repricing caused by climate change. The Paris climate targets can be met with the existing technology, but countries' pledges are insufficient for success and further measures are required. *Romani's* closing remark is worth considering: implementation of the 'leave-no-one-behind' principle makes it possible to complete the carbon-neutral transition in time.

In his presentation, *Ma Jun,* Special Advisor to the Governor of the People's Bank of China, described the pillars of the Chinese green framework, the central element of which is the taxonomy used to identify green activities. Similar to the European Commission's taxonomy,[1] its main aim is to determine the activities that can be considered sustainable, thereby curbing the spread of 'greenwashing'. China has developed three different taxonomies, one for lending, another one for green bonds and a third one for green projects.

[1] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

Jo Paisley, Co-President of the GARP Risk Institute, discussed financial institutions' exposure to climate risks. While institutions mainly see the opportunities offered by climate change in the next five years, over the long run the negative effects dominate. When it comes to quantifying risks, only a marginal proportion of firms believe that climate risks are priced adequately, which may pose a significant issue when they do materialise. A common framework should be established to ensure the comparability of the results of the models quantifying the effects of climate change, both at the local and the global level.

During the panel discussion, *Linda Zeilina,* CEO of International Sustainable Finance Centre, compared the current situation to a potential future Minsky moment arising from climate change, where regulatory bodies need to take unconventional measures to protect the economy.

Katalin Sipos, Director of WWF Hungary, pointed out the benefits of financing a habitat restoration project, stressing that as a first step, it is always more effective to reduce emissions than engaging in carbon offsetting projects. Besides climate change, an emergency is caused by the reduction of the world's environmental capital, and habitat restoration projects may have a direct positive effect.

Opportunities for a green recovery

No central bank can disregard the climate change transition risks, said MNB Deputy Governor *Csaba Kandrács,* in his presentation held in the second session. In cooperation with the NGFS,[2] the MNB wishes to develop a climate stress test that assesses the vulnerability of the economy in three scenarios. The Deputy Governor explained that the MNB had introduced an unprecedented green capital requirement discount scheme for banks in 2020 that is expected to boost, via lending, the renovation of Hungarian buildings, which have low energy efficiency. Another objective is to enhance the market for green financial products in Hungary and focus institutions' attention on sustainable risk management.

Sean Kidney, CEO of Climate Bonds Initiative, underlined that humanity needs to face the negative effects of climate change, which may not always be evident (such as extreme weather events), as for example pandemics similar to Covid-19 may also become more frequent. Fortunately, in itself, the reallocation of the capital amassed around the world for financing sustainable projects would be enough for a climate-neutral transition. The only task is to provide the necessary green financial instruments, for example in the form of green bonds.

[2] Network of Central Banks and Supervisors for Greening the Financial System

Representing the energy sector, *Gurbuz Gonul,* Director for Country Engagement and Partnership at IRENA,[3] presented the programme of this 161-member, international organisation, which principally aims to foster the transition to renewables. According to IRENA's estimates, investments of USD 2 trillion per year are required in the energy sector in 2021–2023 to achieve the climate targets laid down in the Paris Agreement. More than half of the investments need to go towards improving energy efficiency, while the second largest area to be financed is renewable energy production.

Green bonds in Central Europe

Jacek Kubas, Associate Director of the EBRD, opened the panel discussion with four participants by describing the three features of green bonds, namely awareness-raising, action and accountability. In cooperation with the EBRD, the Hungarian regulatory authorities will develop a sustainable capital market strategy to catalyse (non-sovereign) green bond issuances, which are still in their infancy. According to *Flavia Micilotta,* a partner at Deloitte Luxembourg, the state subsidies that have been financing the transition should be replaced by inclusive market instruments, offering access to this source of financing to both funders and issuers. *Christian Zima,* Senior Fund Manager at Raiffeisen Capital Management, believes that green bonds are characterised by substantial excess demand, and issuing them is easier than one would think. *Gregor Lojk*, Chief Financial Officer of GEN-I Group, reported a complete lack of market experience as the first green bond issuer in Slovenia. The only reference points they had were the Green Bond Principles, i.e. the relevant international standard. The fact that they regarded transparency and accountability, required by the standards, as opportunities, earned them the confidence of investors, which paved the way for the successful issuance.

Nowadays it is perhaps becoming widely accepted that climate change and its economic impact cannot be ignored by regulators, market participants or even individuals, and that successful implementation of the efforts described above is in everyone's best interest, and is also the responsibility of the financial sector, even in the 'shadow' of the Covid pandemic. The conference contributed to this with the presentations and discussions on the financial solutions and financial regulatory measures necessary for the green turnaround, as well as with messages that can prove useful for Hungarian and foreign players in the coming months.

The presentations of the conference are available at https://www.mnb.hu/greenfinance/english, and a recording of the entire event can be watched on the MNB's YouTube channel.

[3] International Renewable Energy Agency

INSTRUCTION FOR AUTHORS

Manuscripts should be submitted in accordance with the following rules.

- The length of the manuscripts should be limited to 40,000 characters (including spaces) but a ± 25–50 per cent deviation is accepted. Manuscripts should be written in Hungarian and/or English.
- 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 of the FER only. Papers are peer-reviewed by two independent and anonymous reviewers.
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Thank you!

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