4 FINANCIAL AND ECONOMIC REVIEW

December 2020
Vol. 19 Issue 4

Financial and Economic Review

Scientific journal of the Magyar Nemzeti Bank

Publisher: Magyar Nemzeti Bank
Publisher in Charge: ESZTER HERGÁR
H-1054 Budapest, Szabadság tér 9.
http://english.hitelintezetiszemle.hu/
ISSN 2415–9271 (Print)
ISSN 2415–928X (Online)

Cover design: MARIANNA IZSÓNÉ BIGAI

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Published regularly every three months.
HU ISSN 2415–9271 (Print)
HU ISSN 2415–928X (Online)

Page setting and printing:
Prospektus Kft.
H-8200 Veszprém, Tartu u. 6.

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Interest Savings of the Hungarian Budget between 2013 and 2019 in Comparison with Other EU Countries*

Gergely Kicsák – Dávid Benkő – Noémi Végh

This paper compares the decline in government interest expenditure in Hungary and other Member States of the European Union. Government interest expenditure decreased across the whole EU between 2013 and 2019, and the second largest drop was recorded in Hungary, with government interest payments diminishing from 4.5 per cent of GDP to 2.3 per cent. To understand the cause of this development, favourable even by EU standards, the change in interest expenditure was divided into three main factors: the yield and interest effect, the impact of the change in the debt ratio and the influence of foreign currency debt. The analysis showed that the decrease in Hungarian expenditures can be attributed mostly – by about 80 per cent – to declining domestic yields, while the fall in the debt ratio had a somewhat lesser effect – around 18 per cent. Had foreign currency debt levels been lower, Hungary's interest expenditure would have shrunk even more.

Journal of Economic Literature (JEL) codes: E42, H50**,** H62, H63

Keywords: general government, interest expenditure, monetary policy

1. Introduction

The study examined the general government's accrual-based interest expenditure in the European Union between 2013 and 2019. The analysis sought to identify the factors that contributed to the drop in interest expenditure in the different countries. The authors also wished to assess Hungary's reduction in expenditure by international comparison. Among European Union Member States, the contraction in interest expenditure was the second highest in Hungary during the period under review, reaching 2.2 per cent of GDP. To understand the reasons behind

* 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 authors wish to thank Gergely Baksay, Balázs Csomós, Gábor P. Kiss and Dániel Babos for their valuable comments during the preparation of the study. Any mistakes are the authors' own.

The Hungarian manuscript was received on 12 June 2020.

DOI: http://doi.org/10.33893/FER.19.4.526

this favourable place in the rankings, the main driver of the reduction should be examined. By using a method similar to the debt decomposition employed by *Kicsák* (*2017*), the change in interest expenditure from one year to the next was divided into three main factors for all EU Member States (*Annex, Table 1*). These three primary factors are the yield and interest effect, the impact of the change in the debt ratio and the influence of foreign currency debt. The results attest that the yield and interest effect has the greatest explanatory power among the factors, as it explains around 80 per cent of the reduction in interest expenditure in Hungary between 2013 and 2019, whereas on average, across the EU, almost 100 per cent of the drop in interest expenditure is explained by the contraction in yields. Therefore one might argue that the fall in government interest expenditure is due to the decrease in yields on the government securities market on account of the central bank programmes, the favourable macroeconomic developments and the international abundance of liquidity in recent years. The reduction in the debt ratio explains approximately 18 per cent of the interest savings relative to GDP, which could have been even higher if the foreign currency debt had been lower.

Chapter 2 provides an overview about the relevant background in literature. The following *Chapter 3* presents the development of interest expenditure in Hungary and the EU, as well as the annual and cumulative interest savings since 2013. *Chapter 4* gives a brief description about the methodology analysing the reasons behind the decrease in interest expenditure, before turning to the detailed discussion of the findings in *Chapter 5*, where the effects of the three factors influencing interest expenditure are examined in an international comparison. The *chapters after that* present the three main effects one by one, placing them in context within the European Union. In the *final chapter*, the conclusions are drawn.

2. Overview of literature

The study is based partly on *Kicsák* (*2017*), which examined the development of interest expenditure in Hungary between 2000 and 2015, focusing mainly on the relationship between the decrease in yields and interest expenditure between 2013 and 2015. The paper finds that in the CEE region, the interest expenditure relative to GDP shrank the most in Hungary, by 0.8 percentage points, between 2008 and 2015. The emergence of the favourable yield environment that facilitated the reduction was supported heavily from 2013 by the central bank programmes, i.e. the interest rate cuts, as well as the Self-Financing Programme mitigating Hungary's external vulnerability. Based on an analysis similar to the methodology employed in this study, the paper considers the change in yields to be the largest factor in the drop in interest expenditure, followed by the change in the debt ratio and the effect of foreign currency debt. This study breaks down interest expenditure into factors not only for Hungary, but also for the entire European Union, and the change in yields

has been expanded with non-market loans to capture the effect of the emergency loans from the IMF and the ESM. This is expected to reduce the amount of other, uncategorised effects in *Kicsák* (*2017*).

Earlier studies include *Izák* (*2009*), which examined the development of the primary budget balance and government debt of post-Soviet countries and also presented the effect on debt of real interest rates, among other fiscal variables. That paper finds that, with the exception of Poland, post-Soviet countries were able to stabilise their debt-to-GDP ratios appropriately, even with a negative primary budget balance. However, in Poland, this stabilisation could only occur with a positive primary budget balance, as the real interest rate exceeded GDP growth between 1999 and 2006.

The analysis of fiscal policy's sustainability is often based on the sustainability of government debt. In the literature on fiscal sustainability, the seminal paper by *Blanchard* (*1990*) starts with the budget constraint. According to the definition, the present value of future budget surpluses should equal the present debt. In such a scenario, one cannot determine whether the present fiscal policy is sustainable, because the above requirement is also met with a subsequent adjustment, as noted by *Tóth G.* (*2011*). In his study, *Tóth G.* analyses the sustainability of Hungarian government debt, and divided the period between 1999 and 2010 into three economic policy phases based on debt dynamics and its reasons. In the period between 1999 and 2001, government debt declined by almost 10 percentage points owing to economic growth and the primary budget balance. The increase in the debt ratio in excess of 13 percentage points between 2002 and 2006 was mainly caused by the negative primary budget balance and high real interest rates, which was only partly offset by economic growth. By the end of the third period (2007–2010), which also includes the early years of the 2008 global economic crisis, debt climbed by another 15 percentage points or so to over 80 per cent of GDP. What is more, this growth happened in the context of a neutral primary budget balance effect, mainly on account of the economic downturn and high real interest rates.

Tóth G. (*2014*) analysed the sustainability of public finances based on the data from 27 Member States of the European Union. The author used past data to test five different methods as to how effective they were in forecasting the unsustainability of the budget. The main finding of the paper was that the forecasting ability of the methods was limited (with the exception of the primary budget gap), probably due mainly to the impact of the variables outside fiscal policy. The author also pointed out that the outcome of the individual forecasts depended heavily on the choice of econometric methods.

The analyses on debt sustainability focus not only on debt levels but also on their structure as well as debt management. In his study, *Panizza* (*2008*) underlined that

besides total government debt, the development of the ratio between external and domestic debt was also important. He also stressed the importance of the structure of debt. According to *Guscina* (*2008*), political stability is important, just like an appropriate institutional background and a sound macroeconomic environment, because these form the basis for the development of the domestic government securities market. The most important consequence of this is the rising demand for long-term bonds denominated in the domestic currency, which allows the average term to maturity of government debt to be extended. As the maturity extends, the annual gross financing need diminishes, which considerably reduces countries' financing risk. *Das et al.* (*2010*) examined the relationship between the level of debt, debt management and financial stability. The authors claim that debt management can mitigate risks through buybacks, switch auctions and derivative transactions, moreover the investor base should be diversified and floating-rate bonds should be issued.

Hemming and Petrie (*2000*) developed a multivariate framework for measuring fiscal vulnerability. Their analysis classified indicators into seven categories, including those describing the initial fiscal position (e.g. deficit, government debt), expenditure and revenue indicators (e.g. the value of transfers relative to GDP, distribution of revenues). They also took into account the indicators measuring short-term risks on government debt (e.g. the foreign currency ratio of the debt) as well as those measuring long-term risks (e.g. the change in debt in the next five years). The authors' analysis also included variables describing the implementation of the budget as well as indices on the government's efficiency, thereby incorporating institutional characteristics in the study.

Baksay et al. (*2012*) examined the relationship between debt financing and FX reserves, finding that FX issuance may have a major impact on increasing FX reserves, and it apparently incurs lower interest expenses for the government, but the situation is far from favourable at the level consolidated with the central bank. The paper states that under the circumstances at that time, the savings derived from the lower interest rates on the foreign currency debt were offset by the net interest losses sustained by the central bank, caused by the interest difference between the additional liquidity arising from the FX conversion and sterilised at the base rate on the one hand, and the FX placed in the FX reserves invested at a lower rate on the other hand. Therefore in the case of foreign currency debt, the interest saving of the state is offset by the deterioration in the central bank's profits.

Turner – Spinelli (*2012*) analysed the difference between the interest rate on government debt and economic growth (r-g), from the perspective of fiscal sustainability. They found that this difference was quite low in the 2000s relative to the 1980s and 1990s, partly because of the low volatility of inflation and the credible and low inflation targets. The authors argue that with a given primary

budget balance and initial debt ratio, the greater the difference between interest rates and growth, the greater the change in the debt-to-GDP ratio.

The *Bundesbank* (*2017*) examined the interest expenditures of euro area countries, specifically Germany. It found that interest savings in the euro area were close to 9 per cent of GDP between 2008 and 2017. From the perspective of this analysis, one particularly relevant result of the study is that the development of interest expenditure was mainly determined by the change in yields. Germany saw its interest expenditure relative to GDP decline from 3.5 per cent of GDP to below 1.5 per cent between 1995 and 2016, facilitated by the considerable, 5 percentage point, drop in yields, despite the growing debt. In several euro area countries, while debt rose between 2000 and 2015, government interest expenditure decreased.

Lentner (*2015*) examined the overhaul of the Hungarian public finance system in the wake of the 2008 crisis. The author found that growth and the stabilisation of the financial system were supported from 2010 by the governance model based on burden-sharing and state engagement in the economy, and from 2013 by the unconventional monetary policy. Financing costs were reduced considerably by the Magyar Nemzeti Bank's (the Central Bank of Hungary) rate-cutting cycle that started in 2012, the Funding for Growth Scheme launched after that, as well as the Self-Financing Programme. *Matolcsy* (*2019*) reached similar conclusions in his analysis of the Hungarian monetary policy environment and fiscal developments. He argued that the consolidation of the budget deficit and the stimulation of economic growth pointed towards a reduction in government debt, and the monetary easing from 2013 had a favourable effect on the general government's interest expenditure through the fall in government securities market yields.

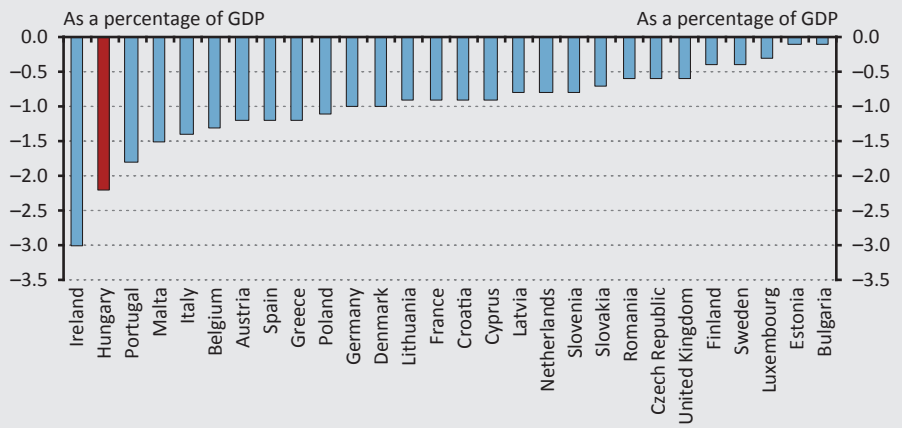
3. Change in interest expenditure and main reasons behind it in an international comparison

The Hungarian government's interest expenditure dropped from 4.5 per cent of GDP to 2.3 per cent between 2013 and 2019 (for more details, see *Kicsák 2017*)*, which was the second largest contraction in the EU.* This means annual Hungarian interest expenditure diminished by almost half in this period, which played a huge part in the reduction of government debt as well. The results of this study show that the yield and interest effect and the impact of the debt ratio explain over 80 per cent and around 18 per cent of the decrease in interest expenditure in Hungary, respectively, which would have been even greater had the amount of foreign currency debt been lower. Moreover, interest expenditure declined in Hungary while the share of domestic funds within debt financing increased considerably.

The interest expenditure of the Hungarian budget shrank significantly, by almost half, between 2013 and 2019, therefore the state's interest savings amounted to

2.2 per cent of GDP in 2019 (*Figure 1*). The coordinated operation of the two main branches of economic policy supported the reduction in interest expenditure from 2013. Independent monetary policy and the central bank's innovative and targeted instruments effectively supported sustainable public finance developments in cooperation with fiscal policy (*Matolcsy – Palotai 2018*). The positive impact of this coordination led to a decline in the government's interest expenditure, alongside results in several other areas of the economy. As shown later in more detail, the large savings are mainly attributable to the drop in yields, and partly to the reduction in the debt ratio, which is continuously supported by lower interest expenditure, creating a feedback loop.

Figure 1
Changes in the budget's interest expenditure in 2013–2019



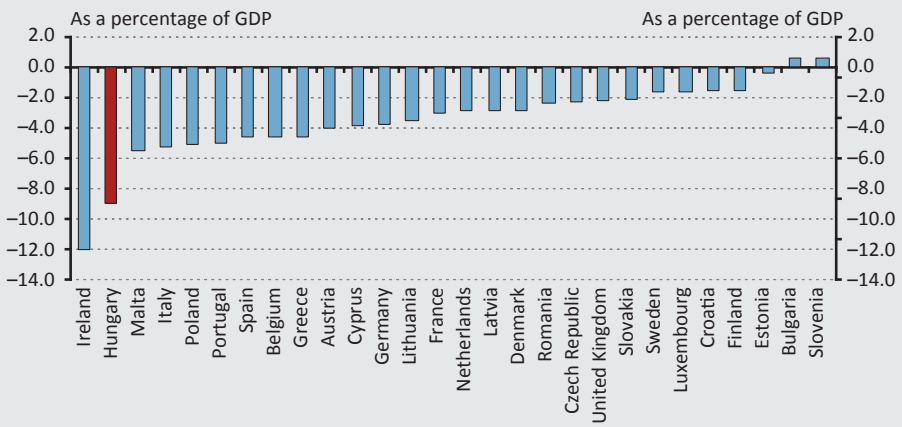
Source: Eurostat

The Hungarian reduction in expenditure was only outstripped by Ireland, mainly on account of Irish GDP growth. Many international corporations, chiefly large IT firms, moved their registered address to Ireland due to the favourable tax conditions. In 2015 Ireland's GDP increased by over 25 per cent, and it grew by over 8 per cent three times in 2013–2019; this is mostly attributable to the fact that large corporations moved there, and partly to the Irish economy's own growth.

Another interesting example is the case of Portugal, the country with the third largest drop, and Greece, where interest expenditure decreased due to the favourable rates on loans as part of the EU–IMF bailout package. Since the items with market rates make up a small share of the Greek government debt, the whopping reduction of market yields had a smaller effect. From the perspective of interest expenditure relative to GDP, the low interest on international loans

was partly offset by the demand-constraining effect of the fiscal adjustment set as a precondition for the bailout packages, and this played a large part in the fact that the Greek economy's real output declined in three years during the period under review.

Figure 2
Cumulative change in the budget's interest expenditure in 2013–2019

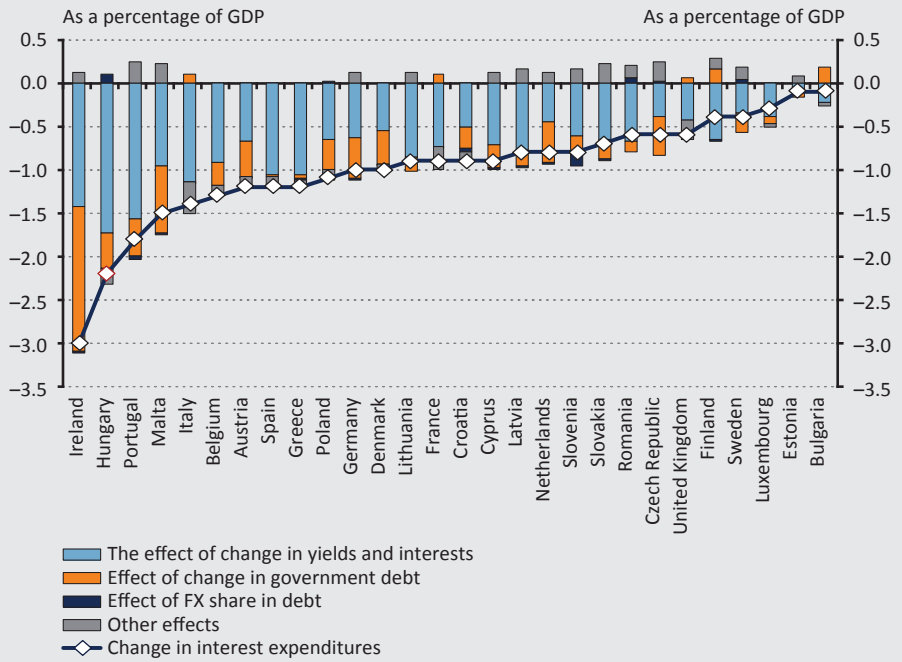


Source: Eurostat

The government's interest savings amounted to 9 per cent of GDP in Hungary, with only the Irish figure coming in higher, at 12 per cent of GDP (*Figure 2*). The cumulative savings illustrate the positive debt spiral that is also exemplified by Hungary. The essence of this positive spiral is that the decline in interest expenditure makes a marked contribution to the reduction in government debt, then the decreasing debt affects interest expenditure, thereby reducing the costs of debt servicing even more. The new model used in Hungarian economic policy after 2010 and the central bank's rate-cutting cycle and its Self-Financing Programme contributed to the improved sustainability of the budget significantly, through the fall in yields and the steady reduction of the government debt (*Kicsák 2015*).

The examples mentioned here show that different developments were the main drivers of the change in expenditure in each country. To identify these drivers and to understand what caused the substantial drop in interest expenditure in Hungary, which stands out by international comparison, the change in interest expenditure was divided into *three main factors: the yield and interest effect, the impact of the change in the debt ratio, and the influence of foreign currency debt* (*Figure 3*).

Figure 3
Structure of the changes in interest expenditure in 2013–2019



Source: Edited based on Eurostat, Bloomberg, ECB data

The breakdown shows that in the EU countries, the contraction in interest expenditure was influenced the most by the change in yields and interest rates, in turn resulting from the global economic growth, the abundance of liquidity and loose monetary conditions in Europe (and the whole global economy). At the outbreak of the 2008 economic crisis, the European Central Bank (ECB) responded with quick rate cuts, however, it only started government bond purchases to reduce the interest rate spreads of Mediterranean countries in 2010 (*Csutiné et al. 2017*). Due to its size, however, the programme was only able to halt the rise in the spreads, no sustained fall in yields was achieved, which contributed to preserving the high government debt ratios in southern countries (*Matolcsy – Palotai 2018*). In several countries, it can also be observed that the expenditure-reducing effect of the change in yields and interest rates is coupled with an almost neutral, or even expenditure-increasing effect of the debt ratio. In other words, the low interest rate environment concealed the negative effects arising from the stagnation or growth of the debt ratio in this period. This may even pose a risk later on, because when yields grow, the countries that were unable to lower their government debt considerably in 2013–2019 may see a rise in interest expenditure coupled with a sudden deterioration in the budget balance. This may push these countries into a negative debt spiral, and crisis management may also place a much greater burden

on the budget and its sustainability. Hungary faces no such risk thanks to the steady and sustained debt reduction in recent years.

4. Simplified presentation of methodology used to decompose change in interest rates

Building on the debt decomposition methodologies, the analysis sought to examine the change in interest expenditure through the years by capturing three macroeconomic factors separately within the change. The decomposition was based on *Kicsák* (*2017*), however, the tools used there were updated, with enhancements and expansions in several respects, to make them suitable for examining all EU countries with some simplifications.

The effect of the change in yields and interest rates was measured using the benchmark yields available for each country. If the change in the yield (r) is calculated for the debt denominated in the domestic currency (D^{DOM}) and expressed as a percentage of GDP, in theory that should give the effect of the yield change in the given year ($eff_{\Delta r}$). However, government debt does not immediately pay the given year's yield, because the time it takes for the different debt items to be repriced to the new yield level varies. Therefore the yield change has to be adjusted for this repricing time. Due to the debt profile of the different countries, the pace of repricing may vary across countries and even at different times, however, due to the lack of data, and as a simplification, the Hungarian repricing pace was used. Thus a sensitivity analysis was performed for the pace of repricing, and it was found that even if another pace was used, no material difference would be detected in the results. The analysis also took into account the fact that the EU–IMF bailout packages also affect interest expenditure, which partly conceals the impact of the yield change in these countries. The formula from *Kicsák* (*2017*) was updated and parametrised for the current period and country group during the quantification of the yield effect, and the weights of the repricing pace were re-estimated.

$$eff_{\Delta r} = \sum_{i=0}^{6} \frac{(r_{t-i} - r_{t-i-1}) \cdot D_{t-i}^{DOM}}{GDP_{t-i}^{nom}} \cdot \frac{x_{i+1}}{100}, \quad (1)$$

where x is the extent of repricing in each year and x = [33,13,11,10,10,9,14].

The impact of the change in the debt ratio ($eff_{\Delta D\_rate}$) is the product of the difference between the debt ratio in the given year and the preceding year on the one hand and the given year's implied interest rate (I_t^{imp}) on the other. The implied interest rate for the given year is calculated as the ratio of the nominal interest expenditure in the given year and the nominal debt in the preceding year. The change in the debt ratio was revisited, simplified and improved in several respects compared to the measure used in *Kicsák* (*2017*), and it is now applicable to all EU countries. The

analysis estimates the effect of the change in government debt in a single step, in contrast to the earlier study, where it was estimated broken down into three factors (real growth, GDP deflator, nominal debt dynamics). The authors believe that the change in the debt ratio does not need to be broken down into three parts to estimate an effect.

$$eff_{\Delta D\_rate} = (D_t^{rate} - D_{t-1}^{rate}) \cdot \frac{I_t^{imp}}{D_{t-1}^{nom}}, \quad (2)$$

$$\text{where } I_t^{imp} = \frac{I_t^{nom}}{D_{t-1}^{nom}}.$$

The *interest rate effect of the foreign currency debt* (eff_{FX_D}) can be calculated by multiplying the difference between the value of the current year's foreign currency debt (D_t^{FX}) at the given year's exchange rate and the preceding year's exchange rate (X_t and X_{t-1}) with the implied interest rate (I_t^{imp}), which is the difference between the FX interest expenditure payable in the given year and the value of the FX interest expenditure in the given year at the preceding year's exchange rate. This is then expressed as a percentage of nominal GDP (GDP_t^{nom}). The formula is also based on the methodology used in *Kicsák* (*2017*), however, similar to the formula quantifying the effect of the change in the debt ratio, the formula from there is simplified and improved to a great degree here:

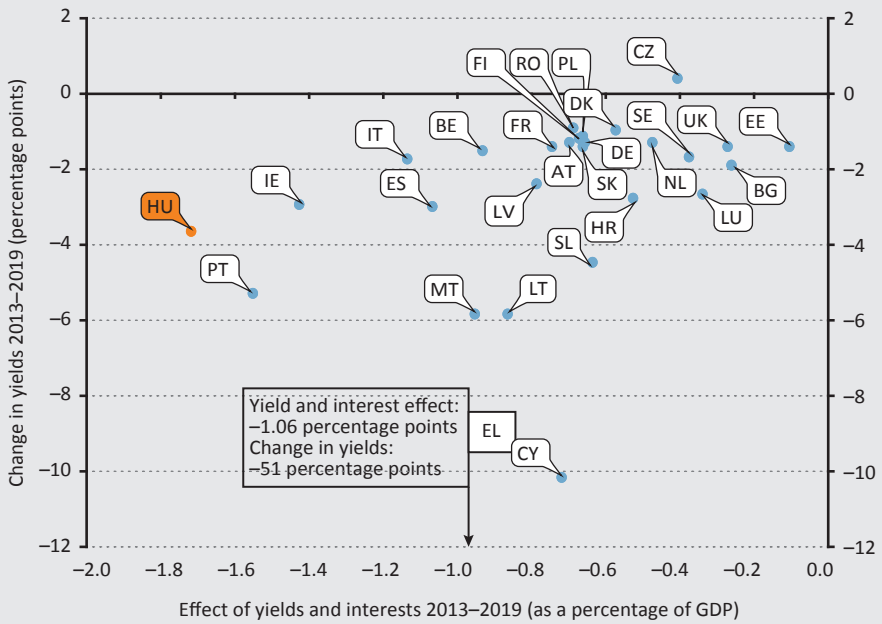
$$eff_{FX\_D} = \frac{\left(D_t^{FX} - D_t^{FX} \cdot \frac{X_{t-1}}{X_t}\right) \cdot I_t^{imp}}{GDP_t^{nom}}. \quad (3)$$

5. Effect of the changes in yields and interest rates on interest expenditure

The above methodology shows that *the change in government securities yields and lending rates reduced the government's interest burden in all countries under review.* Hungary's interest expenditure declined by 1.73 percentage points as a result of the yield and interest rate changes in the period under review, putting *Hungary first among European Union Member States in the ranking based on the change in yields and interest rates* (*Figure 4*). The development of Hungarian yields was influenced favourably by the coordinated operation of the two branches of economic policy. The independent monetary policy was able to use rate-cutting cycles to adequately and steadily push government securities market yields down, while the targeted central bank measures, such as the Self-Financing Programme, had a positive effect on the structure of government debt. The growth-stimulating fiscal policy placed the Hungarian economy on a growth path far outstripping the average of EU and developed countries (*Matolcsy – Palotai 2019*). Moreover, the favourable international environment, international growth and the abundance of

liquidity on money and capital markets all contributed to the decrease in yields on the Hungarian government securities market. Nevertheless, the positive yield effect was indirectly reduced by the large share of foreign currency-denominated debt, because on account of the longer maturities and the limited room for manoeuvre in FX debt management only a smaller portion of the holdings was repriced to the more favourable domestic yield level, while the rates on foreign currency debt remained high.

Figure 4
Change in average government securities market yields and estimated effect of the change in yields and interest rates on interest expenditure, 2013–2019



Note: We marked the countries with two-digit codes for the sake of transparency.
Source: Edited based on Eurostat, Bloomberg, ECB data

While estimating the yield and interest effect, the analysis took not only the change in market yields into account: the repricing of government debt, in other words, the time when the effect of the given yield change actually takes hold, was also considered after the change in weighted average benchmark yields was determined. Furthermore, efforts were also made to take the change in the rate on non-market loans into consideration. This was achieved by quantifying the effect of the change in yields, then the unexplained part was used to estimate the interest impact of outstanding loans and EU, IMF and World Bank bailout packages. The non-linear relationship between average market yields and the estimated yield and interest effect emerged by taking several factors into account (*Figure 4*).

Interest expenditure was considerably reduced in several countries by the emergency loans provided by international organisations at much more favourable rates than market yields. These loans fixed the interest expenditure of the countries receiving the bailout at a low level, therefore no major drop in yields is reflected in the interest expenditure between 2013 and 2019 (best exemplified by Greece in *Figure 4*), and the impact of the skyrocketing yields during the crisis (which is not covered by the analysis) cannot be observed either. These types of package may have improved the ranking of Greece, Portugal, Ireland, Spain, Latvia, Cyprus and Romania in the ranking in *Figure 1*, while Hungary prepaid its IMF loan taken out in 2008–2009 at the beginning of the period under review, and 2016 saw the settlement of the loan from the EU as well. Hungary's position was not improved by the interest payment on the EU loan either, because for the most part in the period under review, the fixed euro-denominated interest on the EU loan was higher than the interest rate available to Hungary on the forint market at that time. The prepayment of the IMF loan not only provided interest earnings but also helped extend the residual maturity of the government debt, because the government financed the loans that would have matured within 2–3 years mainly by issuing long-term, 5–10-year securities. In 2013–2019, as a result of the low-interest loans facilitated by the bailout package, interest expenditure shrank the most in Greece, which had come close to a state bankruptcy.

Effect of emergency loans on interest expenditure

The IMF credit line and the European Union's financial stability funds provide financing at low interest to countries in dire financial straits for external or domestic reasons. This is often necessary precisely because of the rise in government securities market yields that occurs due to the sudden spike in CDS spreads, since the increase in interest expenditure may push the budget into a negative spiral. The bailout packages most often provide a credit line at much better rates than those available on the market, and debtors need to repay the loans at medium-term maturities. To access the IMF credit line, beneficiary countries need to make comprehensive economic policy commitments, with the primary objective of resolving the state's financial difficulties and gradually enabling it to repay the loan.

The European Stability Mechanism offers low-interest emergency loans to euro area countries to manage the funding risks arising in the fiscally heterogeneous currency union, thereby stabilising the euro area when necessary. The ESM has provided emergency loans to five countries, enabling Greece to make interest savings of over 5 per cent of GDP and Cyprus to secure savings of almost 2 per cent of GDP until 2016 (*ESM 2017*). However, in the case of Spain, Ireland and Portugal, this figure was below 1 per cent of GDP. Since Greece was in the deepest

economic crisis among the five countries, it can be stated that the higher the market yields that jump due to the CDS spreads, the greater the interest savings available by utilising a preferential emergency loan.

Hungary has requested a drawdown (stand-by) credit line from the IMF under the Stand-By Arrangement several times since the 1980s. The largest one was the latest, starting in November 2008 and amounting to over SDR 10 billion, which was part of a complex loan arrangement, partly financed by the European Union and worth EUR 19 billion. The credit line was mainly necessitated by government securities market turbulences, the unstable capital position of the financial sector and the low levels of the central bank's foreign currency reserves. In the end, Hungary withdrew EUR 14.3 billion from the total amount, and it repaid the loan in full in April 2016. This made Hungary the first to repay its loan among the countries that took out crisis management loans for funding purposes at the time of the 2008–2009 crisis. The repayment of the loan reduced the foreign currency ratio and foreign ownership within government debt, and the entire funding of Hungary's debt was placed on a market footing. Alongside the reduction in vulnerability, the Hungarian central bank's rate cuts and the Self-Financing Programme introduced in a moderate inflation environment, the disciplined fiscal policy, the drop in the CDS spread and the accommodative external environment reduced Hungarian yields to below the interest on the EU and IMF loans, making debt financing even cheaper (*Kicsák 2016*).

According to the calculations, the yield and interest effect is around 0.5–1.5 per cent of GDP in most countries, and it is only higher in Hungary and Portugal. This figure is lower than 0.5 per cent of GDP in the Netherlands, the Czech Republic, Sweden, the UK, Luxembourg, Bulgaria and Estonia. In the Czech Republic and the UK, the low effect is attributable to the small drop in yields, while the low values in Estonia, Luxembourg and Sweden are explained by the large amounts of non-market funds obtained, as loans make up around 30 per cent of the debt in the two latter countries and almost 90 per cent in Estonia, which may slow down the repricing of government debt to a low yield level as the interest is fixed for a long term.

6. Effect of the debt ratio on the interest rate

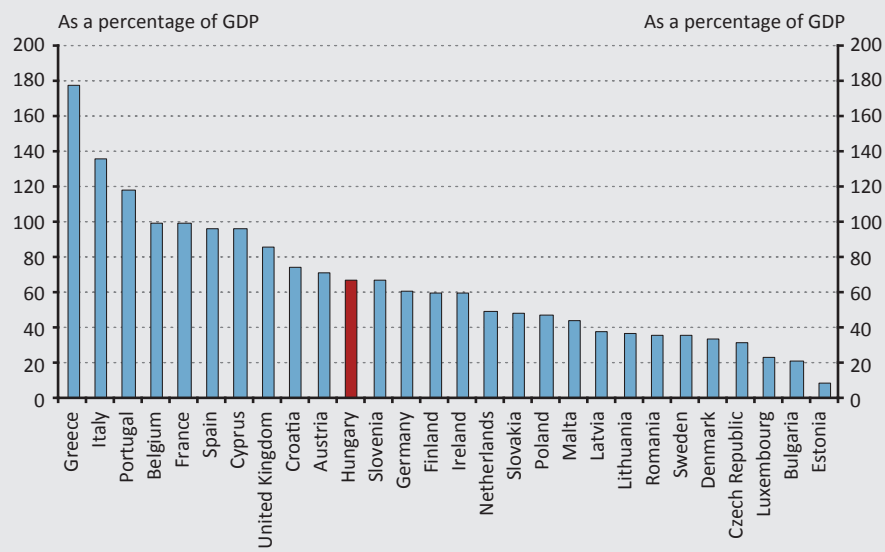
Besides the change in yields and interest rates, the other major factor influencing interest expenditure is the development of government debt. The interest rate effect of the debt ratio essentially shows the combined effects of several macroeconomic developments. These include the real growth of the economy and the effect of the GDP deflator, which together produce nominal growth. The impact of nominal debt also takes hold through this effect, and within that the revaluation of foreign

currency debt is another important factor. The analysis examines the change in the debt ratio, which captures all these factors, as well as its effect on interest expenditure, since the most important measure of government debt is the debt-to-GDP ratio (also included in the EU's fiscal rules), which compares countries' output to their indebtedness.

EU countries' indebtedness declined in the period under review because the debt-to-GDP ratio calculated with the weighted average of the Member States diminished from over 86 per cent to around 79 per cent, and 23 out of 28 countries saw their government debt decrease. Owing to the continuous contraction in the Hungarian debt ratio since 2011, it was around 13 percentage points lower than the EU average at the end of 2019. This places Hungary around the EU average in terms of the debt ratio's size. In the CEE region, the Hungarian figure is lower than in Croatia, and higher than in Slovenia, Slovakia, Poland, Romania and the Czech Republic (*Figure 5*).

Government debt in Greece, Italy and Portugal was well over 100 per cent of GDP, and exceeded 175 per cent in Greece. By contrast, government debt amounts to merely around 20 per cent of GDP in Luxembourg and Bulgaria, and it amounts to roughly 8 per cent of GDP in Estonia, the country with the lowest amount of debt.

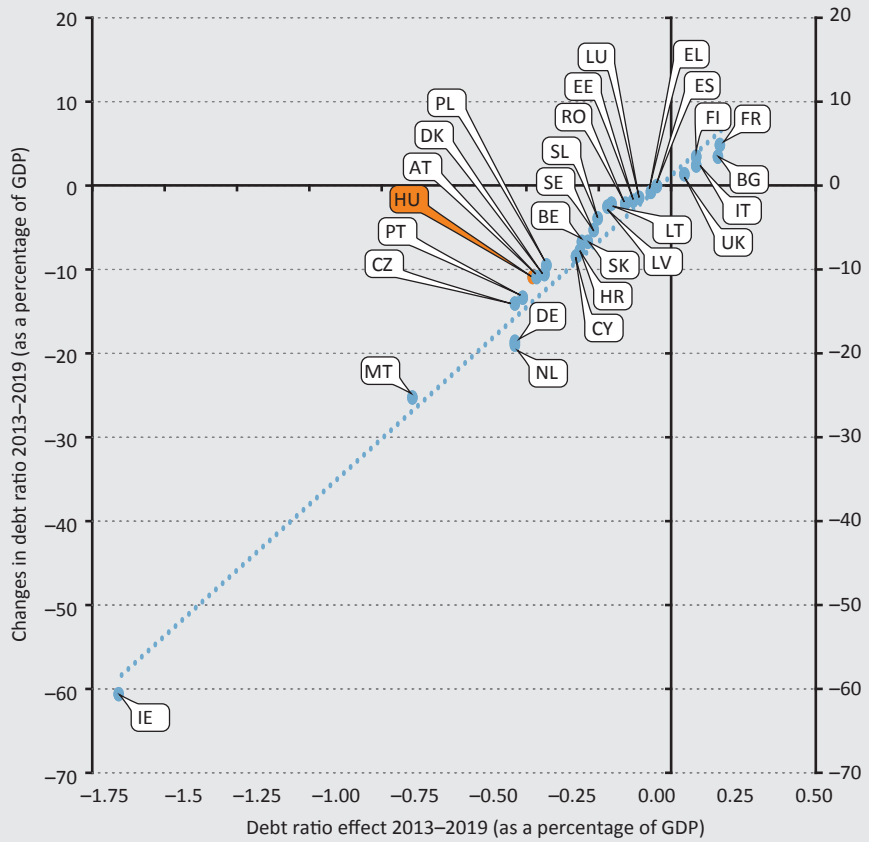
Figure 5
Gross government debt in EU countries at the end of 2019



Source: Eurostat

According to the estimates in this paper, interest expenditure declined by 0.4 percentage points in Hungary as a result of the debt reduction, which has continued steadily since 2011, a feat unparalleled in the EU. The greatest debt reduction occurred in Ireland and Malta in the period under review (*Figure 6*). When estimating the effect of the debt ratio on interest expenditure, the main factor taken into account was the change in government debt, and only a slight adjustment was used, for example taking into account the rapid increase or decrease in debt within the year and the change in the average term to maturity. As a result, the interest rate effect of the debt ratio correlated strongly with the underlying variable used, i.e. the change in the debt ratio (*Figure 6*).

Figure 6
Change in debt ratio and effect of the change in debt on interest expenditure, 2013–2019



Note: We marked the countries with two-digit codes for the sake of transparency.
Source: Edited based on Eurostat, Bloomberg, ECB data

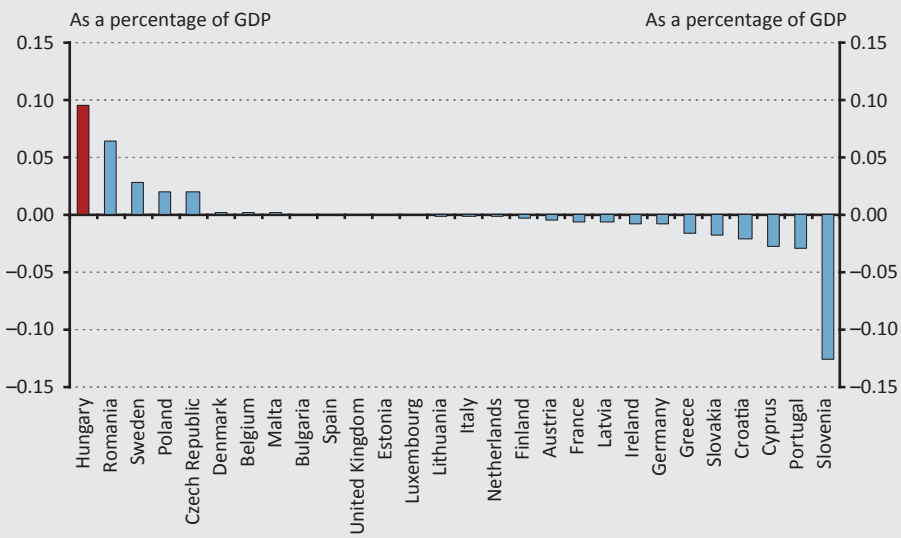
Hungary is ranked seventh as regards the impact of government debt. There are 23 countries in total where the debt effect reduced interest expenditure in the period under review, while the impact of the debt ratio varies between –0.5 and +0.5 per cent of GDP, with the exception of the first two countries. An effect raising interest expenditure can be observed in five countries, but the decrease in yields and interest rates offset the expenditure growth in these countries too, so the interest expenditure ultimately did not climb there either.

In several countries, the decline in the debt ratio was influenced by strong economic growth. This effect was particularly strong in Ireland and Malta, so the debt ratio diminished the most in these two countries. In other countries, for example Germany and the Netherlands, the main reason behind the significant improvement in the debt ratio was not economic growth but the budget surplus derived from the disciplined fiscal policy, which curbed the growth of nominal debt.

7. Effect of foreign currency debt on interest expenditure

The overall effect of the foreign currency debt on interest expenditure is quite moderate, and it should be treated separately from the revaluation of foreign currency debt, which can be found in the debt ratio effect, because here the focus is on the change in the value of the given FX interest payment expressed in the local currency. In Hungary's case, this direct effect refers to how the fixed FX interest payments developed in forint terms.

Figure 7
Effect of foreign currency debt on interest expenditure, 2013–2019

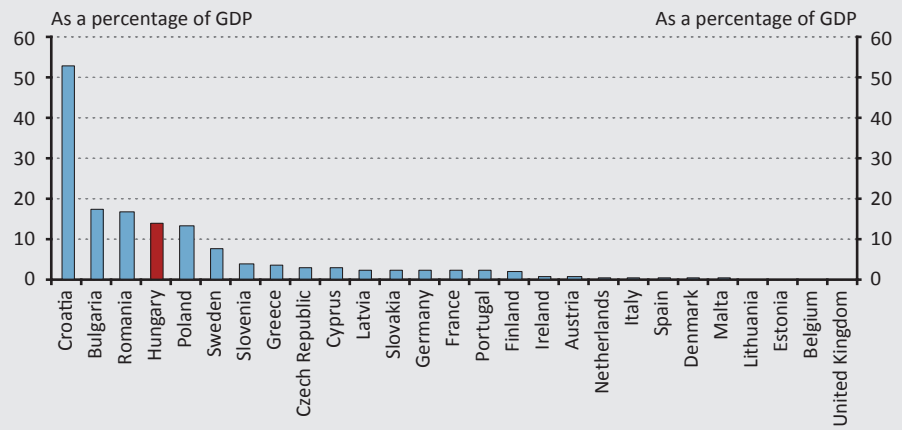


Source: Edited based on Eurostat, Bloomberg, ECB data

The interest effect of foreign currency debt lifted interest expenditure by 0.1 percentage point in Hungary, which was the greatest additional interest burden growth in the EU. *Figure 7* shows that several countries of the CEE region experienced this effect, since Hungary is followed directly by Romania in the ranking, and Poland and the Czech Republic are also close behind. Several Member States, especially in the euro area, were indebted in the common currency only, and in such cases the interest effect of the foreign currency debt is, accordingly, zero. The expenditure declined in the countries where the domestic currency appreciated against the currency in which the indebtedness occurred.

The main reason behind the large FX effect, which outstripped other countries in the region, is that in 2019 Hungary had the fourth greatest foreign currency debt-to-GDP ratio among European Union Member States (*Figure 8*). However, in the EU countries with a higher foreign currency debt than Hungary, the exchange rate regime is much more rigid. In Croatia and Romania, the exchange rate against the euro moves within a tight band (stabilised arrangement), while in the even more rigid Bulgarian regime a currency board operates, in contrast to Hungary's floating exchange rate regime (*IMF 2020*).

Figure 8
Foreign currency debt-to-GDP ratio in European Union Member States in 2019



Source: ECB

Impact of euro area accession on foreign currency ratio within government debt

In the case of several countries, the time series presenting the share of foreign currency debt show a slump in the year of joining the euro area. This is because the foreign currency debt of the countries joining the currency union was primarily denominated in euros in the years leading up to their euro area membership. The dip after the joining was the most marked in Baltic states that have a higher foreign currency ratio (60–80 percentage points), but in Cyprus and Slovenia the foreign currency debt of 20–30 per cent diminished to around zero. Of course, debt outstanding in dollars, Swiss francs, yen or other currencies remained foreign currency debt even after the euro was introduced.

However, euro area members have no independent monetary policy toolkit at their disposal that they could use as with their earlier, own currency. The euro area crisis that emerged from the 2008 global economic crisis showed in the southern peripheral countries of the euro area (Greece, Portugal, Italy, Spain) that the funding difficulties caused by being deprived of an independent monetary policy while being part of a suboptimal currency area with no common fiscal policy may offset the advantages derived from the reduction in foreign currency debt (*Benkő 2013*).

8. Summary

The study examined the development of the Hungarian budget's accrual-based interest expenditure in an international context. The analysis framework was provided by a decomposition method that helps break the change in interest expenditure down into factors, and this decomposition facilitated the establishment of the effects and macroeconomic developments that led to the reduction in expenditure. Moreover, the factors' relationship to underlying variables was also evaluated.

Among the European Union countries, Hungary recorded the second greatest drop in interest expenditure between 2013 and 2019, amounting to 2.2 per cent of GDP. Although the interest burden of government debt contracted in all EU countries, savings greater than in Hungary were only observed in Ireland. The total interest savings amounted to 9 per cent of GDP in Hungary in the period under review. Together with the primary budget surplus, these large savings created a positive debt spiral: the fall in interest expenditure helped reduce the debt ratio, while the diminishing debt reduced interest expenditure even more.

The decomposition of the change in interest expenditure into factors shows that within the European Union the yield and interest effect was the largest in

Hungary (at 1.73 per cent of GDP), and it alone contributes around 80 per cent of the reduction in expenditure. The marked plunge in yields was facilitated by the central bank measures introduced in the low inflation environment (rate-cutting cycle, Self-Financing Programme, restructuring the central bank's toolkit), which was supported by Hungarian macroeconomic developments, the disciplined fiscal policy and the international environment.

The contraction in the debt ratio explains a fall in interest expenditure amounting to 0.4 per cent of GDP, which places Hungary seventh in the EU ranking, and this caused approximately 18 per cent of the total reduction in the expenditure. This decline is primarily attributable to the fact that Hungary's debt ratio has been steadily diminishing since 2011. As a result, the country's debt level was 13 percentage points lower than the EU average in 2019. In itself, the change in the debt ratio reduced interest expenditure in 23 countries and increased it in 5 in the period under review. Overall, interest expenditure did not surge even in places where debt grew, because in such cases the drop in yields offset the negative effect of indebtedness.

Foreign currency debt has a marginal effect on interest rates in most of the countries under review. In Hungary, the foreign currency debt itself caused an additional interest burden increase of 0.1 per cent, which means slightly higher interest savings could have been achieved with a lower foreign currency debt level. Several euro area countries have negligible or no foreign currency debt, therefore no such effect arose there.

All in all, the fact that interest expenditure in Hungary diminished considerably, even by EU comparison, is to a large extent explained by the fall in government securities market yields, facilitated by the coordination between the two main branches of economic policy – fiscal and monetary policy – strengthened further by the steadily declining trend of the debt ratio since 2011, and held back only moderately by the negative effect of foreign currency debt.

References

Baksay, G. – Karvalits, F. – Kuti, Zs. (2012): *The impact of public debt on foreign exchange reserves and central bank profitability: the case of Hungary*. BIS Papers, No 67: 179–193. https://www.bis.org/publ/bppdf/bispap67l.pdf

Baksay, G. – Berki, T. – Csaba, I. – Hudák, E. – Kiss, T. – Lakos, G. – Lovas, Zs. – P. Kiss, G. (2013): *Developments in public debt in Hungary between 1998 and 2012: trends, reasons and effects*. MNB Bulletin, 2013(Special Issue): 14–22. https://www.mnb.hu/letoltes/baksay-berki-csaba-hudak-kiss-lakos-lovas-pkiss.pdf

Benkő, D.J. (2013): *A Merkel-kormány válságkezelése a német belpolitika tükrében* (*The Merkel Cabinet's Crisis Management in view of German Domestic Policy*). BA/BSc thesis, BCE Nemzetközi Tanulmányok Intézet (Institute of International Studies), Budapesti Corvinus Egyetem (Corvinus University of Budapest).

Blanchard, O. (1990): *The Sustainability of Fiscal Policy: New Answers to an Old Question*. OECD Economic Studies, 15(Autumn): 7–36.

Bundesbank (2017): *The development of government interest expenditure in Germany and other euro-area countries.* Monthly Report, July, Deutsche Bundesbank.

Csutiné Baranyai, J. – Lehmann, K. – Mérő, B. (2017): *The ECB in new territory – „Whatever it takes"?* In: Lehmann, K. – Palotai, D. – Virág, B. (eds.): The Hungarian Way – Targeted Central Bank Policy. MNB Book Series, Magyar Nemzeti Bank.

Das, U.S. – Papapioannou, M – Pedras, G. – Ahmed, F. – Surti, J. (2010): *Managing Public Debt and Its Financial Stability Implications*. IMF Working Paper WP/10/280, International Monetary Fund. https://doi.org/10.5089/9781455210879.001

ESM (2017): *Evaluation Report.* EFSF/ESM Financial Assistance, European Stability Mechanism. https://www.esm.europa.eu/sites/default/files/ti_pubpdf_dw0616055enn_pdfweb_20170607111409_0.pdf. Downloaded: 6 April 2020.

Guscina, A. (2008): *Impact of Macroeconomic, Political, and Institutional Factors on the Structure of Government Debt in Emerging Market Countries*. IMF Working Paper WP/08/205, International Monetary Fund. https://doi.org/10.5089/9781451870633.001

Hemming, R. – Petrie, M. (2000)*: A Framework for Assessing Fiscal Vulnerability.* IMF Working Paper WP/00/52, International Monetary Fund. https://doi.org/10.5089/9781451847246.001

IMF (2020): *Annual Report on Exchange Arrangements and Exchange Restrictions 2019*. International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions/Issues/2020/08/10/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions-2019-47102

Izák, V. (2009): *Primary balance, public debt and fiscal variables in postsocialist members of the European Union*. Prague Economic Papers, 18(2): 114–130. https://doi.org/10.18267/j.pep.345

Kicsák, G. (2015): *A 2012-2015-ben bevezetett jegybanki intézkedések hatása az államháztartás finanszírozására* (*The Effect of the Central Bank Measures Introduced in 2012–2015 on the Financing of the General Government*). Szakmai cikk (Article), Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/15-06-29-kicsak-gergely-a-2012-2015-ben-bevezett-jegybanki-intezkedesek-hatasa-az-allamhaztartas-finanszirozasara.pdf. Downloaded: 6 March 2020.

Kicsák, G. (2016): *Az EU-hitel utolsó részletének törlesztése egyszerre csökkentette az ország sérülékenységét és az adósságfinanszírozás költségét* (*The Repayment of the Last Instalment of the EU Loan Reduced both Hungary's Vulnerability and the Cost of Debt Financing*). Szakmai cikk (Article), Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/kicsak-az-eu-hitel-utolso-reszletenek-visszafizetesemnbhonlapra.pdf. Downloaded: 6 March 2020.

Kicsák, G. (2017): *Developments in Government Interest Expenditure for Hungary, 2000–2015*. Financial and Economic Review, 16(1): 46–73. https://en-hitelintezetiszemle.mnb.hu/letoltes/gergely-kicsak.pdf

Lentner, Cs. (2015): *Az új magyar állampénzügyi rendszer – történeti, intézményi és tudományos összefüggésekben* (*The New Hungarian Public Finance System – in a Historical, Institutional and Scientific Context*). Pénzügyi Szemle (Public Finance Quarterly), 60(4): 458–472.

Matolcsy, Gy. (2019): *A sikeres válságkezelés a 12 gazdasági fordulat tükrében* (*Successful Crisis Management in the Light of the Twelve Economic Turnarounds*). Polgári Szemle (Civic Review), 15(1–3): 15–45. https://doi.org/10.24307/psz.2019.0903

Matolcsy, Gy. – Palotai, D. (2018): *The Hungarian Model: Hungarian Crisis Management in View of the Mediterranean Way.* Financial and Economic Review, 17(2): 5–42. http://doi.org/10.25201/FER.17.2.542

Matolcsy, Gy. – Palotai, D. (2019): *Hungary Is on the Path to Convergence.* Financial and Economic Review, 18(3): 5–28. http://doi.org/10.33893/FER.18.3.528

Panizza, U. (2008): *Domestic and External Public Debt in Developing Countries*. United Nations Conference on Trade and Development Discussion Paper No. 188. https://doi.org/10.2139/ssrn.1147669

Tóth, G.Cs. (2011): *Adósságdinamika és fenntarthatóság* (*Debt Dynamics and Sustainability*). Statisztikai Szemle (Hungarian Statistical Review), 89(12): 1242–1268.

Tóth, G.Cs. (2014): *A költségvetés fenntarthatóságát mérő mutatók előrejelző képessége* (*The Forecasting Capacity of Indicators Measuring Budget Sustainability*). Pénzügyi Szemle (Public Finance Quarterly), 2014(4): 544–561.

Turner, D. – Spinelli, F. (2012): *Interest-rate-growth differentials and government debt dynamics.* OECD Journal: Economic Studies, 2012(1): 103–122. http://dx.doi.org/10.1787/eco_studies-2012-5k912k0zkhf8

Annex

Table 1
Structure of the change in interest expenditure in 2013–2019 (percentage of GDP)

	Effect of changes in yields and interest rates	Effect of change in the debt ratio	Effect of FX debt on interest rate	Other effects	Change in interest expenditure
Ireland	–1.43	–1.66	–0.02	0.11	–3.00
Hungary	–1.73	–0.40	0.09	–0.15	–2.20
Portugal	–1.56	–0.43	–0.05	0.24	–1.80
Malta	–0.95	–0.77	0.00	0.22	–1.50
Italy	–1.14	0.10	0.00	–0.36	–1.40
Belgium	–0.92	–0.25	0.00	–0.13	–1.30
Austria	–0.68	–0.39	–0.01	–0.12	–1.20
Spain	–1.06	–0.02	0.00	–0.12	–1.20
Greece	–1.06	–0.04	–0.02	–0.08	–1.20
Poland	–0.65	–0.36	0.02	–0.11	–1.10
Germany	–0.64	–0.45	–0.01	0.11	–1.00
Denmark	–0.56	–0.37	0.00	–0.07	–1.00
Lithuania	–0.85	–0.16	0.00	0.11	–0.90
France	–0.73	0.10	–0.01	–0.26	–0.90
Croatia	–0.51	–0.26	–0.04	–0.09	–0.90
Cyprus	–0.71	–0.27	–0.03	0.11	–0.90
Latvia	–0.78	–0.17	–0.01	0.16	–0.80
Netherlands	–0.46	–0.46	0.00	0.12	–0.80
Slovenia	–0.62	–0.20	–0.14	0.16	–0.80
Slovakia	–0.65	–0.24	–0.02	0.21	–0.70
Romania	–0.68	–0.12	0.05	0.14	–0.60
Czech Republic	–0.39	–0.45	0.01	0.24	–0.60
United Kingdom	–0.42	0.06	0.00	–0.24	–0.60
Finland	–0.66	0.16	0.00	0.10	–0.40
Sweden	–0.36	–0.22	0.03	0.14	–0.40
Luxembourg	–0.39	–0.08	0.00	–0.04	–0.30
Estonia	–0.08	–0.10	0.00	0.08	–0.10
Bulgaria	–0.24	0.17	0.00	–0.03	–0.10

Source: Edited based on Eurostat, ECB and Bloomberg data

How Would the Magyar Nemzeti Bank's Liquidity and Funding Requirements Have Influenced the Impact of the 2008 Crisis in Hungary?*

Tamás Borkó – Evelyn Herbert – Barnabás Székely – Péter Szomorjai

Building on the experiences from the financial crisis, after 2012 the Magyar Nemzeti Bank (MNB, the Central Bank of Hungary) introduced various regulations managing liquidity and funding risks that affected the whole banking system, disincentivising the emergence of business practices jeopardising short- and long-term solvency. The instruments addressing currency mismatches, for example the Foreign Exchange Funding Adequacy Ratio, the Foreign Exchange Coverage Ratio, the Interbank Funding Ratio as well as the Liquidity Coverage Ratio introduced at the EU level reduce the probability of system-wide liquidity and funding shocks in Hungary and may keep the Hungarian banking system's short-term external vulnerability permanently low. By backtesting the impact of the above-mentioned regulations, this analysis confirms that these instruments would have been effective in curbing the emergence of the banking system vulnerabilities observed prior to the 2008 crisis. It can also be argued that, by internalising the costs of the riskier funding practices in the banking system, they would have been able to slow the pace of the build-up of the FX loans that later led to devastating effects in the national economy and society, and to mitigate the risks related to excessive lending.

Journal of Economic Literature (JEL) codes: E58, G01, G21

Keywords: financial stability, liquidity, funding, macroprudential policy, short-term external debt, FX lending

1. Introduction

The 2007 crisis spread quickly from the credit market to other financial markets of the US,[1] and all over the globalised financial market. It underlined the significance

* 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 authors wish to thank Gabriella Grosz and Laura Komlóssy for their help in the preparation of the study as well as János Szakács for his valuable comments. Any remaining mistakes are the sole responsibility of the authors.

The Hungarian manuscript was received on 15 June 2020.

DOI: http://doi.org/10.33893/FER.19.4.2759

[1] For the detailed reasons and consequences of the US subprime mortgage crisis, see: *Dell'Ariccia et al.* (*2012*) *and Demyanyk – Hemert* (*2011*).

of liquidity in the appropriate operation of financial markets and the banking sector. Cheap funding used to be readily available in the context of active asset markets, however, the quick realignment on the markets showed how rapidly liquidity can evaporate. The banking system experienced extreme stress, which required central banks to act and support financial markets and, in some cases, individual institutions (*BCBS 2013*).

The magnitude of the economic costs incurred in the financial crisis demonstrated the crucial importance of the stability of the financial system and the low vulnerability of the economy in a country's resilience to shocks. It also underscored that in themselves the so-called microprudential interventions, which ensure the stability and the prudent operation of individual banks, are unable to prevent financial malfunctions that inflict heavy losses on the real economy, and it became clear that systemic macroprudential interventions to manage financial system risks were also necessary. Besides actively curbing systemic financial risks, financial players' individual resilience to risks also had to be effectively improved.

An international response was triggered to manage the shortcomings in liquidity management: the Basel Committee on Banking Supervision prepared two standards, one on liquidity and another one on funding (*BCBS 2013; BCBS 2014*), in accordance with which the Liquidity Coverage Ratio (LCR) was introduced across the EU in 2015, and the Net Stable Funding Ratio (NSFR) will take effect in 2021. However, these are not always able to manage all the risks that arise at the national level, therefore national liquidity and funding regulations complementing the EU requirements may also be necessary.

The 2008 crisis had a major, albeit indirect effect on the Hungarian banking system. The country's financial vulnerability back then was mainly attributable to household FX lending and the liquidity and solvency risks arising from the related FX funding need. Building on the Hungarian experiences from the financial crisis and taking into account the features of the Hungarian financial system, the MNB introduced various regulations managing liquidity and funding risks that disincentivised the emergence of business practices jeopardising short- and long-term solvency, even before the Basel ratios took effect. At the bottom of the financial cycle, in the context of a practically marginal adjustment requirement, the Deposit Coverage Ratio (DCR) and the Balance Sheet Coverage Ratio (BCR) targeting short-term liquidity risks and functioning as simple LCR indicators were introduced[2], together with the Foreign Exchange Funding Adequacy Ratio (FFAR), the Foreign Exchange Coverage Ratio (FECR) and the Interbank Funding Ratio (IFR) addressing funding risks, and the Mortgage Funding Adequacy Ratio (MFAR) ensuring forint maturity matching. Coupled with the above-mentioned LCR, these requirements function

[2] When the LCR took effect, the two indicators were removed from the MNB's instruments.

as preventive instruments that are able to reduce the probability of system-wide liquidity and funding shocks in Hungary and may keep the Hungarian banking system's short-term external vulnerability permanently low.

Based on the experiences since the crisis, and being especially important in view of the financial and economic shocks emerging in the wake of the coronavirus pandemic, the question arises of what approximate effects the introduction of such rules might have. Therefore a thought experiment is conducted utilising the experiences from the global financial crisis, examining the extent by which the implementation of these rules prior to the crisis would have reduced the vulnerability of the financial system and thus also the economy as a whole. Accordingly, the study aims, on the one hand, to assess the impact of the rules had they been implemented before the 2007–2008 crisis, and on the other hand, to ascertain how this framework can prevent the build-up and materialisation of vulnerabilities in the future, because the lessons learnt also provide information about this.

The backtesting calculation performed in this way suggests that the regulatory framework under review would have significantly reduced short-term interbank external debt. With an asset-side adjustment, the volume of FX loans should have contracted considerably as well, or it would have been unable to build up in the first place, due to the regulatory constraints. It has to be noted, however, that several strong assumptions needed to be made to perform the calculations here; so even though the authors are convinced that the findings are a good approximation for the system as a whole, this analysis merely paints a rough picture about the effects of the regulatory framework.

The *second chapter* of the study comprises a review of the theoretical and empirical literature on the importance of liquidity and funding regulations. The *third chapter* presents the features of the Hungarian banking system in the financial crisis that started in 2007–2008, as well as the liquidity and funding regulatory instruments implemented after the crisis. The *fourth chapter* details the research conducted, while the *fifth* lists the findings. Finally, the study ends with a summary.

2. Liquidity and funding risks

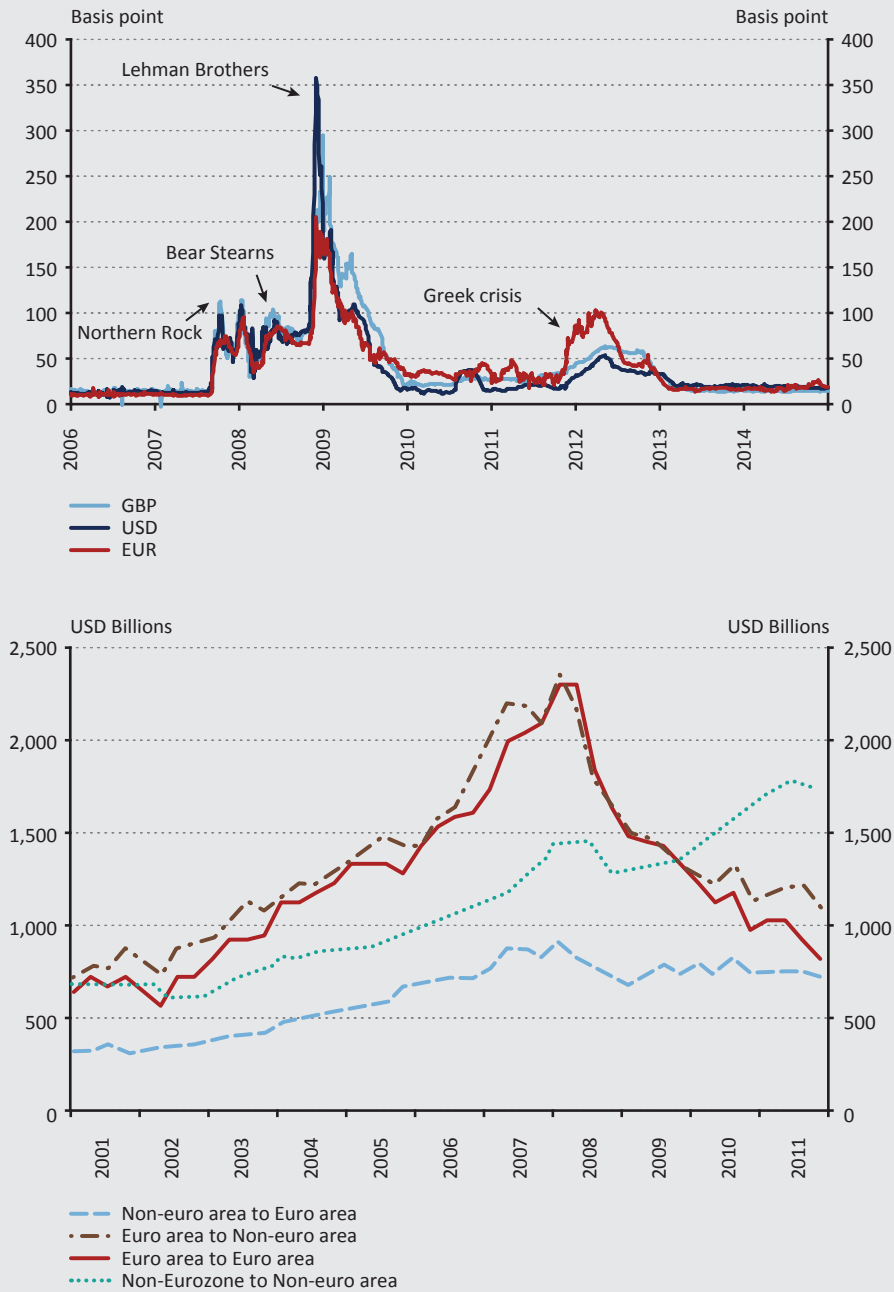
2.1. Liquidity and funding risks in general

Credit institutions typically perform maturity transformation during financial intermediation, offering long-term loans against their short-term liabilities. Hence they allow borrowers to smooth their consumption and investment cycles, which increases social welfare but also poses a liquidity risk to credit institutions.

Traditionally, liquidity has been defined as the credit institution's ability to fund increases in assets and meet obligations as they fall due (*BCBS 2000*). According to literature, banks' liquidity risks have two distinct but related dimensions: funding risk (creditworthiness on the market) and market liquidity risk (ability to sell or unwind asset positions) (*ECB 2002*). The former is the risk that credit institutions are unable to meet their payment obligations, or only at the expense of a massive reduction in profitability. Funding risks may arise, for example, due to an unexpected drop in the liquidity available to banks on account of individual problems or a liquidity shortage on the money market, or a sudden surge in liquidity demand triggered by an unanticipated withdrawal of funds or credit line drawdowns. Funding risk is heightened if banks' liabilities include a low amount of customer deposits that are considered so-called core liabilities, making banks rely heavily on other, less stable forms of funding. Market liquidity risk means that credit institutions may only be able to sell their financial assets with a major price loss due to financial market turbulences, turning otherwise liquid assets into illiquid ones (*Balás – Móré 2007; Sharma 2004*). Funding and market liquidity risks are closely related and may influence each other (*Acharya – Schaefer 2005; Brunnermeier – Pedersen 2007*). This mutual dependence may deal a heavy blow to financial markets under unfavourable circumstances, since the disturbances on a few segments can easily spill over to others, which may undermine the liquidity of the entire market.

The interaction between market and funding liquidity risks was illustrated by the subprime mortgage crisis in the US that began in 2007. As investor confidence was dented, the market for collateralised debt obligations (CDOs) became increasingly illiquid, and the trapped investors had no choice but to unwind other positions, which made the liquidity stress spread quickly to other markets as well. Parallel to the unwinding of the positions, the reduction of funding liquidity and deleveraging began. Since banks were not only funders but also active investors on the market, they were forced to do multiple rounds of write-downs. The lack of transparency and the uncertainty also had a negative effect on the interbank market, the funding market based on the confidence among banks; this led to an unprecedented jump in interbank rates, and to the interbank market grinding to a halt (*Balás – Móré 2007; Nagy – Szabó 2008; Hungarian Financial Supervisory Authority* (*HFSA*) *2013*) (*Figure 1*).

Figure 1
Difference between 3-month interbank rate and O/N index swap (upper panel), and development of interbank funds (lower panel) prior to and after the 2008 crisis



Source: Bloomberg, BIS International banking statistics

The crisis showed how important the funding structure is in banks' resilience to shocks. As interbank rates soared and the interbank market dried up, banks with an over-reliance on interbank funds were affected by the crisis much more severely. It has been empirically proven for Canada, the UK and the EU countries that the banks that financed their operations to a lesser extent from customer deposits and to a greater extent from interbank funds were clearly more vulnerable during the crisis (*Poghosyan – Čihák 2009; Ratnovski – Huang 2009; Yorulmazer – Goldsmith-Pinkham 2010*). The banking business model built on an extensive credit expansion financed to a large degree from foreign and FX funds also caused serious problems in certain countries as the crisis progressed. This practice led to a banking crisis in Iceland, where banks first experienced a major tightening of the funds available from international markets, then foreign depositors also started to withdraw their money, leading to a collapse of all three major banks in Iceland (*Baudino et al. 2020*).

2.2. Key risks in funding

2.2.1. FX lending

The expansion in FX lending may pose a risk to financial stability in several ways. In the cases where domestic borrowers without a foreign currency hedge have FX debt, the depreciation of the local currency translates into an increase in the outstanding debt, leading to a deterioration in the debt-servicing capacity of the borrowers. Since the depreciation of the local currency's exchange rate has an adverse effect on a large portion of the private sector holding foreign loans at the same time, a major exchange rate depreciation may generate a systemic financial stability risk for the entire economy (*ECB 2010*). Moreover, borrowers' default risk may be further compounded if the appreciation of the foreign currency is coupled with a rise in foreign interest rates, especially when floating-rate loans make up a large share of outstanding borrowing (*BCBS 2009; Hartmann 2010*).

Any significant deterioration in the quality of the FX loan portfolio could expose banks to substantial profitability risk via the significant decrease of interest income along with the growing write-downs and provisions of banks. Furthermore, the souring of the FX loan portfolio may also entail a funding risk for banks. Their funds reserved for the repayment of their own liabilities may be drastically reduced as a result of the slump or disruptions in loan repayments. Therefore, banks find it increasingly hard to repay their maturing liabilities. This increases their demand for funds and their need to roll over debt, which may be impeded by the damaged confidence of their financers on account of the losses related to the FX loan portfolio. Additional funding risk may emerge if banks finance FX lending from funds in different currencies, covering the currency mismatch with FX swaps. In such a scenario, if liquidity plunges on the FX swap market and banks have no

access to the central bank's instruments providing FX liquidity, a funding risk for FX loans emerges even in the short run (*ECB 2010*). Any potential exchange rate depreciation entails further risks, since then the losses on the swaps are incurred immediately, while the higher inflows from the increased forint-denominated repayment instalments of FX loans take longer to be collected.

2.2.2. Short-term external debt

If external funds dominate an economy's financing structure, that may significantly increase a country's vulnerability. Economies with a scarcity of capital naturally have a need to borrow foreign funds, especially if they are available under better conditions than the domestic funds denominated in the local currency. In times of market turbulences, the greatest drawback of the dependence on external funding is rollover risk, since in crises, foreign funds may become considerably more expensive or even suddenly dry up (*Fábián – Vonnák 2014*). This risk is especially acute in the case of short-term liabilities. Reliance on external savings and FX markets intensifies the volatility of exchange rates and increases expectations about interest rate spreads, which may undermine the economy's ability to raise funds in a crisis. The 2008 global financial crisis showed the risks of external vulnerability and thus also the importance of international FX reserves (*Nagy – Palotai 2014; Csávás 2015*).

2.2.3. Interbank funding

The over-reliance on funds from financial corporations may entail a major systemic risk, which, if it materialises, may have devastating consequences for the financial system and the real economy. In an economy with a high capacity and propensity to save, banks' primary source of finance is the deposits of households and small and medium-sized enterprises (so-called core liabilities). At the same time, in the expansion period of the credit cycle, when credit demand rises faster than the stock of available customer deposits, banks search for alternative sources of finance (so-called non-core liabilities) to supplement the above-mentioned core liabilities and maintain credit growth *(Hahm et al. 2013*). When short-term sources of finance are widespread, rollover risk increases (*Dudley 2014*). In times of uncertainty, financial institutions providing alternative financing may withdraw funds from the market, causing insufficient liquidity (*Huang – Ratnovski 2011*). Fear of contagion may lead to a drop in interbank lending and thus a meltdown of the credit market (*Iyer – Peydro 2011*).

2.2.4. Off-balance sheet financing

A too large currency mismatch in the banking system's balance sheet increases the banking system's reliance on off-balance sheet instruments (FX swaps) due to the exchange rate risk related to the change in the exchange rate, and this can produce

systemic risks. In the case of long-term swaps, the main risk is the change in margin requirements. These increase considerably in the event of a depreciation in the exchange rate, generating additional FX demand and further increasing external vulnerability and the reliance on the swap market. In the case of short-term swap transactions, another risk is posed by the shorter maturity than for the typically long-term FX loans covered by the swap: this makes the rollover risk large, because in the absence of refinancing banks have an open foreign currency position, forcing them to acquire FX funds on the spot market (*Páles et al. 2010*). When it comes to short-term transactions, the drying-up of the swap market is a major threat mainly because if the FX necessary for repaying the foreign currency leg of the maturing FX swap is acquired on the spot market, that may lead to a depreciation of the exchange rate due to the fact that the spot market's volume is much smaller than the FX swap market. There is also the risk that such an acquisition of FX may be impossible in the case of system-wide demand due to the different volumes, and this may prevent the banks from honouring their payment obligations in FX.

3. Lessons learnt from the global financial crisis in Hungary

3.1. The Hungarian banking system in the crisis

The financial crisis that unfolded in 2007 seriously affected the Hungarian banking system, despite the fact that it played no role in the emergence of the crisis or its spillover. The country's financial vulnerability observed during the crisis arose mainly from the liquidity risk caused by the banking system's short-term FX financing need as well as the solvency risk caused by the FX loans. The financial system's weakness and the credit crunch deepened the recession and slowed the recovery (*Nagy – Vonnák 2014*).

The pre-crisis vulnerability is principally attributable to the nominal forint interest rates that were steadily high due to the economic policy in the early 2000s that encouraged consumption, as well as to inflation developments. Moreover, in the inconsistent monetary system of inflation targeting and the exchange rate band, the forint moved against the euro within a tight band, which provided a sense of exchange rate stability and resulted in an underestimation of the exchange rate risk. Households' previously deferred consumption demand and positive income expectations led to a rise in the demand for FX loans (*Nagy – Vonnák 2014*).

The rise in FX lending was coupled with an increase in risks, as banks gradually eased credit conditions in the competition for lending. This business model became increasingly unhealthy in the years leading up to the crisis, with banks relying more and more on foreign, short-term and mostly interbank funds and FX swaps while financing their lending operations. The expansionary economic policy and the Hungarian banking system's FX lending practices produced risky retail and

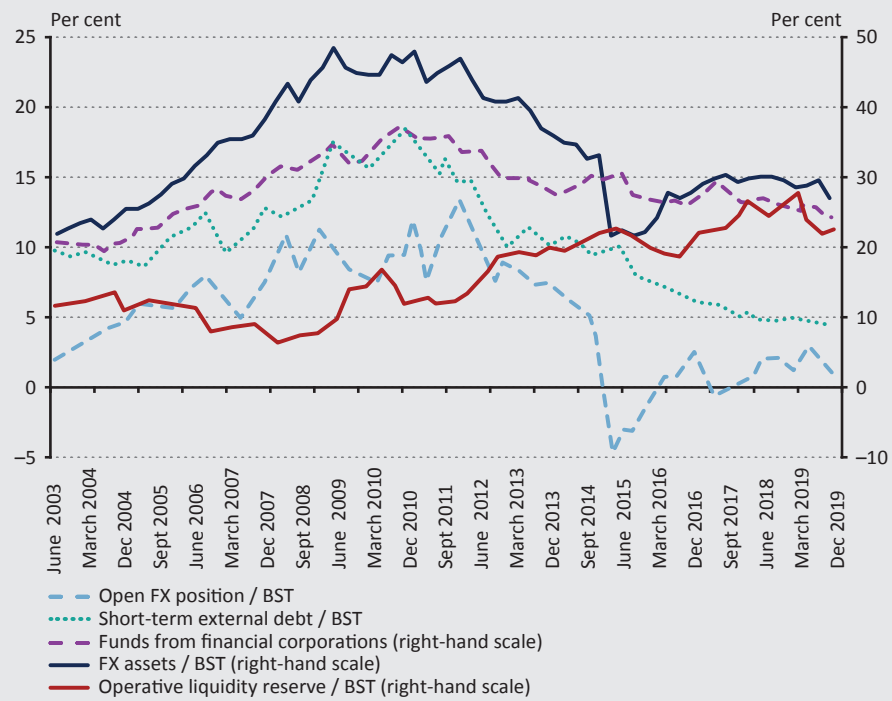
corporate lending. The situation was compounded by the fact that the regulatory authorities sat idly by, as macroprudential responsibilities and powers were not clearly distributed among the institutions (*Fábián – Vonnák 2014*).

Prior to the crisis, banks financed a portion of FX lending from funds denominated in local currency or other foreign currencies, closing some of their on-balance sheet foreign currency positions with FX swap transactions. However, after the financial crisis unfolded, it became considerably harder to acquire FX liquidity, counterparty limits were tightened, and the forint's exchange rate volatility increased. Although the total average turnover on the Hungarian FX swap market did not fall dramatically, market liquidity contracted considerably for a few days, limiting access to FX liquidity. Maturities shortened and active engagement from parent banks was necessary to prevent turnover from plummeting. Implied forint yields became significantly detached from the floor of the interest rate corridor, so FX liquidity could only be acquired at high spreads relative to international interbank rates (*Páles et al. 2010*).

The development of the above vulnerabilities is illustrated by the change in some key indicators over time (*Figure 2*). It is clear that in addition to the rise of FX lending in banks' balance sheets, a financing model primarily resting on short-term FX funds and off-balance sheet risk-taking emerged in the Hungarian banking system before 2008. This was coupled with an ever tightening and overstretched liquidity position, which was indicated by the low and dropping level of operational liquidity reserves[3] before the crisis.

[3] The indicator used for monitoring banks' liquidity position, comprising banks' liquid assets and the contractual net flows of treasury transactions within a 30-day period (portfolio gap).

Figure 2
Development of key banking system indicators relative to the balance sheet total



Note: BST = balance sheet total
Source: MNB

3.2. The MNB's liquidity and funding regulatory toolkit

In the European Union, macroprudential policy has rested on two elements of the Single Rulebook, the CRR[4] and the CRD IV,[5] as well as the related legal acts, since 2013. Macroprudential policy is primarily implemented and operated by Member State macroprudential authorities[6] under the coordination of the European Systemic Risk Board (ESRB). Besides the instruments available under the EU regulatory framework, instruments developed within the national scope of competence can also be applied.

[4] Regulation (EU) No 575/2013 of the European Parliament and of the Council on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012
[5] Directive 2013/36/EU of the European Parliament and of the Council on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC
[6] Depending on the legal implementation, this may be the central bank, the supervisory authority, a ministry or even an independent body.

From 1 October 2013, not only the supervisory, but also the resolution and macroprudential functions have been included in the MNB's mandate according to the decision of the Hungarian Parliament. Among other things, this was why the MNB assumed responsibility for the liquidity and funding instruments offered by the Single Rulebook, such as the LCR, the NSFR that enters into force on 28 June 2021,[7] as well as the liquidity requirements that can be modified under the national flexibility measures pursuant to Article 458 of the CRR. In 2013, the MNB also obtained a mandate to issue decrees[8], which allows it to stipulate macroprudential requirements for bank financing within the national scope of competence.

Therefore, with the exception of the FFAR, which was regulated in a government decree with the cooperation of the competent ministry in 2012,[9] the MNB designed several regulations at its own discretion. The relevant information on these regulations can be found in *Table 1*. Moreover, the LCR used at the EU level was also introduced early within the national scope of competence. The instruments listed here did not require any major adjustment on the part of banks because they were introduced at the bottom of the financial cycle, and they aim to prevent the future build-up of risks.

Table 1
Historical overview of liquidity and funding regulations introduced and revised by the MNB

	Effective date	Content
Introduction of FFAR*	1 July 2012	Introduction of an NSFR-type regulation taking into account the features of the special Hungarian liquidity risks, and managing currency risk as well as the risk arising from the maturity mismatch between assets and liabilities, with a minimum requirement of 65 per cent
Introduction of Deposit Coverage Ratio and Balance Sheet Coverage Ratio*	1 July 2012	Introduction of regulations managing short-term, 30-day liquidity risks
1st review of FFAR	1 July 2014	Requirement in the form of an MNB decree, gradual tightening and the extension of the institutional scope to EU branches
Phase-out of Deposit Coverage Ratio and Balance Sheet Coverage Ratio	30 September 2015	Repeal of the regulations due to the introduction of the LCR

[7] The introduction of the NSFR is laid down in the revised CRR, the CRR2: Regulation (EU) 2019/876 of the European Parliament and of the Council of 20 May 2019 amending Regulation (EU) No 575/2013 as regards the leverage ratio, the net stable funding ratio, requirements for own funds and eligible liabilities, counterparty credit risk, market risk, exposures to central counterparties, exposures to collective investment undertakings, large exposures, reporting and disclosure requirements, and Regulation (EU) No 648/2012
[8] Act CXXXIX of 2013 on the Magyar Nemzeti Bank.
[9] In the absence of the MNB's powers to issue decrees, the FFAR, DCR and BCR ratios introduced on 1 July 2012 were regulated by the government at the MNB's proposal.

Table 1 (continued)
Historical overview of liquidity and funding regulations introduced and revised by the MNB

	Effective date	Content
Introduction of LCR**	1 October 2015	Initial LCR introduction at 60 per cent in line with the EU legislation
2nd review of FFAR	1 January 2016	Raising the required level to 100 per cent and exclusion of net FX swaps beyond the duration of one year from stable FX funding
Introduction of FECR	1 January 2016	Introduction of a regulation maximising on-balance sheet currency mismatch and limiting banks' over-reliance on the FX swap market, with a required maximum level of 15 per cent
1st amendment of LCR**	1 January 2016	Raising the level (70 per cent) in connection with the gradual introduction, consistent with the EU legislation's road map
LCR national discretion	1 April 2016	Shortening the interim period of the requirement within the national scope of competence, and tightening related to an immediate requirement to ensure 100 per cent compliance
Introduction of MFAR	1 October 2016	Introduction of a regulation encouraging an increase in the forint maturity matching through the acquisition of long-term, mortgage-based funds, with a 15-per cent minimum requirement
1st review of MFAR	1 April 2017	Postponement of the introduction with a view to the new regulation on liens
3rd review of FFAR	1 July 2018	Review performed to ensure alignment with the changed bank balance sheet structures and funding business models after the forint conversion as well as with the NSFR
Introduction of IFR	1 July 2018	Introduction of a regulation limiting banks' over-reliance on the funds from financial corporations and the build-up of the systemic risks resulting from this
2nd review of MFAR	1 October 2018	Tightening regarding the required level (20 per cent) and the quality of the eligible funds
3rd review of MFAR	1 February 2019 and 1 October 2019	Tightening regarding the required level (25 per cent) as well as the de minimis limit and the quality of the eligible funds
4th review of MFAR	24 March 2020	Easing related to the effects of the coronavirus, suspension of cross-financing constraints
4th review of FFAR	24 March 2020	Tightening related to the increase in liquidity risk in connection with the effects of the coronavirus
1st review of FECR	24 March 2020	Tightening related to the increase in liquidity risk in connection with the effects of the coronavirus
5th review of FFAR	18 September 2020	Phase-out of the temporary tightening related to the effects of the coronavirus
2nd review of FECR	18 September 2020	Phase-out of the temporary tightening related to the effects of the coronavirus

*Note: *In the absence of the MNB's macroprudential mandate, it was introduced by a government decree in cooperation with the MNB. ** Prescribed by a directly applicable EU regulation.*

Source: MNB

By 2018, a toolkit was available for mitigating and preventing liquidity and funding risks with complementary elements, which would have had a significant effect on the systemic risks that built up prior to the crisis, had they been introduced earlier. However, only the requirements that are relevant for our backtesting exercise are described below, in other words, those that have the greatest impact on the risks related to short-term external financing and FX lending.[10]

- *Liquidity Coverage Ratio:* The liquidity coverage requirement expects banks to hold a sufficient quantity and quality of liquid assets to cover any net outflows assumed in the case of a short-term (30-day) liquidity shock. Compliance with the liquidity coverage requirement can mainly be ensured by increasing the stock of highly liquid assets and by raising longer-term funds.

$$LCR = \text{Liquid assets} / \text{Net liquidity outflows} > 100\%$$

- *Foreign Exchange Funding Adequacy Ratio:* The instrument expects institutions to hold a sufficient amount of stable FX funds aligned with their FX assets that require stable financing (mostly long-term, illiquid FX assets). The impact mechanism of the regulation is twofold. It reduces the risks stemming from on-balance sheet currency mismatches and limits the rise in off-balance sheet liabilities. In addition, with respect to FX liabilities, it encourages banks to use funds embodying stable, long-term financing, thereby reducing the maturity mismatches on the balance sheets of credit institutions. The FFAR can also affect off-balance sheet guarantees. Supplemented by other instruments, such as the FECR, the instrument can also mitigate the external vulnerability of the banking sector.

$$FFAR = \frac{\text{Weighted sum of available stable FX funding}}{\text{Required stable FX funding}} > 100\%$$

- *Foreign Exchange Coverage Ratio:* The regulation imposes a limit on the degree of currency mismatches between assets and liabilities relative to the balance sheet total. The reduction of on-balance sheet currency mismatches also reduces institutions' reliance on off-balance sheet instruments, mainly FX swaps, which, in turn, lowers the risks stemming from these instruments (rollover, liquidity and margin call risks). Supplemented by other instruments, such as the FFAR, the

[10] The Deposit Coverage Ratio and the Balance Sheet Coverage Ratio that targeted short-term liquidity risks and were repealed upon the introduction of the LCR, and the Mortgage Funding Adequacy Ratio (MFAR) designed to ensure forint maturity matching, will not be described here, since these were not included in the backtesting exercise. As the instruments repealed upon the introduction of the LCR managed risks identical to those in the LCR requirement, it seemed sufficient to include the LCR in the analysis. The MFAR seeks to manage the rising forint maturity mismatch in the wake of the forint conversion caused by the appearance of large amounts of long-term forint-denominated mortgage loans on banks' balance sheets, and this risk was negligible before the crisis due to the smaller share of forint-denominated mortgage loans and the higher proportion of mortgage bonds.

instrument can also mitigate risks stemming from the vulnerability of external finance.

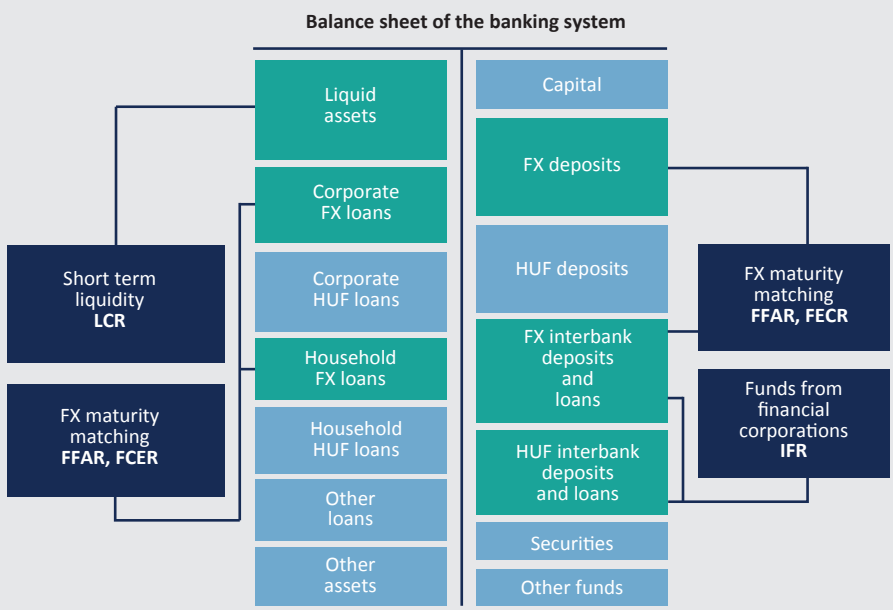
$$FECR = ABS(FX\ assets - FX\ liabilities) / Balance\ sheet\ total < 15\%$$[11]

- *Interbank Funding Ratio:* The regulation limits the sum of the funds from financial corporations weighted by currency and residual maturity relative to liabilities. The targeted measure can effectively prevent the over-reliance on funds from financial corporations.

$$IFR = Weighted\ sum\ of\ the\ funds\ from\ financial\ corporations\ /\ (Balance\ sheet\ total - Equity) < 30\%$$

Overall, the regulations can exert an impact on practically the whole balance sheet of banks, capturing one specific funding or liquidity aspect each, but also complementing each other (*Figure 3*).

Figure 3
Balance sheet impact of the MNB's liquidity and funding rules



Source: MNB

[11] Due to the rising risks in connection with the coronavirus pandemic, the permitted level was temporarily lowered to 10 per cent between 24 March 2020 and 17 September 2020.

4. Backtesting certain liquidity and funding regulations

4.1. Methodology

Had the chosen funding rules capturing the different dimensions of liquidity and FX maturity mismatches been introduced before the crisis, the institutions concerned would have had to adjust to ensure compliance, provided they had not been compliant before. The greatest methodological challenge is that one cannot retroactively determine the exact adjustment channel the banks under review would have used. In this case, stochastic models, which are often used for assessing and testing regulatory measures, do not provide a solution. These models (such as difference in differences, propensity score matching and the synthetic control method) identify control groups and treatment groups and establish their dynamics relative to each other as the effect of the intervention. However, the introduction of the macroprudential framework affected the entire Hungarian banking system uniformly, therefore no appropriate control group can be found. Furthermore, an international outlook would not be of much use either, since the earliest point in the period under review assumes that the macroprudential framework was introduced in 2003. At that time, the ideas of a comprehensive macroprudential policy or the introduction and application of dedicated macroprudential instruments were not floated in other countries either, so no benchmark can be pinpointed relative to which the changes in the Hungarian banking system could be compared.

To get around these problems, a wholly deterministic approach is used: a set of assumptions are made that provide a good approximation of the banking system's adjustment options. Since there is no way to determine how the individual banks would have responded to the regulations listed above, the most viable and cost-effective opportunities are collected by the authors. Of course, no claim is made that all the banks under review would have chosen the adjustment method determined here, the authors merely strove to appropriately approximate the most efficient ways of adjustment *at a systemic level*. It should be underlined though that the calculated values only provide a rough estimation about the effects of the rules under review.

Potential simple adjustment methods that result in a substantial improvement in the indicators and are not so limited by balance sheet constraints were defined, and they were ranked on an expert basis by viability and cost. The adjustment is based on the ranking: banks adjust using the adjustment method ranked first until the relevant limit is reached, then they switch to the method ranked next. The adjustment continues until banks comply with all the requirements for the indicators or as long as they are able to improve their indicators with the pre-defined

adjustment methods. Although we sought to take all aspects into account with due care during the ranking, to minimise the uncertainties arising from expert-based ranking the study focuses on the results that are independent from the ranking determined here, or depend on it to a small degree only. With the exception of the FFAR,[12] the adjustment to the indicators was examined based on the requirements in effect prior to the temporary amendment due to the coronavirus pandemic.

To ensure compliance with the funding indicators, banks would have been forced to adjust by transforming their funding structure on the liabilities side or phasing out FX lending on the assets side. Two scenarios are distinguished according to whether banks are able to adapt on the liabilities side without constraints, or whether it is also necessary to reduce the stock of FX loans. In the *first scenario*, with only a liability-side adjustment, banks increase the amount of their stable FX funds to improve currency and maturity matching, by converting their existing funds to foreign currency, extending maturities or obtaining new long-term FX funds (*Table 2*). In this scenario, it is assumed that method A4, the acquisition of long-term FX funds, has no constraint.

The adjustment's steps and its effects on the indicators are shown in *Table 2*: in the case of Adjustment A1, converting HUF 100 of interbank forint-denominated external funds with maturities of 1–2 years to FX, increases the numerator of the IFR by HUF 10 due to the less favourable weighting of FX funds, thereby slightly deteriorating the indicator's value. However, this transaction improves the value of the FFAR and the FECR, raising the numerator of the FFAR by HUF 100 and reducing the numerator of the FECR by HUF 100. This adjustment is performed by the bank until it complies with all the indicators or until it runs out of its interbank forint-denominated external funds with maturities of 1–2 years. If no more such funds are available, but the bank does not comply with all the indicators, it starts the next adjustment step (A2).

[12] In the case of the FFAR, the FFAR effective before 1 July 2018 was used in the calculations since it is easier to estimate the FFAR at that time in retrospect.

Table 2
Adjustment methods used for adjustment on the liabilities side only, their assumed order, and effects on the indicators

ADJUSTMENT METHOD			EFFECT OF ADJUSTMENT METHOD ON THE INDICATORS			
AM	Asset	Liability	IFR	FFAR	FECR	LCR*
A1	None	Converting interbank forint-denominated external funds with maturities of 1–2 years to FX	Numerator ↑10%	Numerator ↑100%	Numerator ↓100%	0
A2	None	Converting interbank forint-denominated external funds with maturities of over 2 years to FX	0	Numerator ↑100%	Numerator ↓100%	0
A3	None	Extending the maturities of interbank FX-denominated external funds with maturities of 0–1 year to over 2 years	Numerator ↓100%	Numerator ↑100%	0	0
A4	Purchasing forint-denominated government securities	Acquisition of interbank FX-denominated external funds with maturities of over 2 years	Denominator ↑100%	Numerator ↑100%	Numerator ↓100% Denominator ↑100%	Numerator ↑100%

*Note: *The exact effect on the outflows and inflows, where relevant, cannot be estimated. The change in the LCR only reflects the change in liquid asset holdings. In addition, the columns show the effect on the given indicator in the case of the different adjustment methods, as a percentage of the adjustment, i.e. the extent by which one unit of adjustment modifies the numerator or denominator of the indicators, thereby reducing or improving compliance with the regulation. The red shading indicates deterioration in the indicator, while green denotes improvement. A positive initial value was assumed in the case of the FECR.*

In the *second scenario*, when asset-side adjustment is also included, the opportunities for method A4, i.e. acquisition of long-term FX funds, are limited, since it can be assumed that Hungarian banks cannot obtain unlimited FX funds. According to our assumption, banks can only obtain half the amount of funds necessary in the first scenario, which makes it necessary to involve asset-side adjustment affecting FX loan holdings as well (*Table 3*). It is assumed that the FX loan holdings would be reduced by converting the loans to forints.

Table 3
Adjustment methods used for adjustment on both the liabilities and assets side, their order, and effects on the indicators

ADJUSTMENT METHOD			EFFECT OF ADJUSTMENT METHOD ON THE INDICATORS			
AM	Asset	Liability	IFR	FFAR	FECR	LCR*
A1	None	Converting interbank forint-denominated external funds with maturities of 1–2 years to FX	Numerator ↑10%	Numerator ↑100%	Numerator ↓100%	0
A2	None	Converting interbank forint-denominated external funds with maturities of over 2 years to FX	0	Numerator ↑100%	Numerator ↓100%	0
A3	None	Extending the maturities of interbank FX-denominated external funds with maturities of 0–1 year to over 2 years	Numerator ↓100%	Numerator ↑100%	0	0
A4	Purchasing forint-denominated government securities	Acquisition of interbank FX-denominated external funds with maturities of over 2 years	Denominator ↑100%	Numerator ↑100%	Numerator ↓100% Denominator ↑100%	Numerator ↑100%
A5	Reduction of retail FX mortgage loan holdings (forint conversion)	None (off-balance sheet effect, in the FX swap holdings)	0	Denominator ↓65%	Numerator ↓100%	0
A6	Reduction of other retail FX loan holdings (forint conversion)	None (off-balance sheet effect, in the FX swap holdings)	0	Denominator ↓85%	Numerator ↓100%	0

*Note: *The exact effect on the outflows and inflows, where relevant, cannot be estimated. The change in the LCR only reflects the change in liquid asset holdings. Also, see the note to Table 2.*

The adjustment methods presented so far help the adjustment of the banks that financed their FX lending mostly from forint-denominated funds and, to a lesser extent, short-term interbank FX funds. However, a smaller portion of banks operated with a different business model, which resulted in a reverse currency mismatch. These institutions, typically the local branches of large Western European banks, obtained FX funds more cheaply and in larger quantities than their Hungarian peers, then they swapped them to forints with Hungarian counterparties. Therefore they usually had excess FX funds and a FECR below −15 per cent.[13] The adjustment of such institutions required the definition of special adjustment methods, since their FECR compliance would only have been deteriorated by the adjustment methods defined above (*Table 4*).

[13] Although the regulation governs the absolute value of the difference between FX assets and FX liabilities, this paper does not employ absolute values when calculating the FECR values, the indicator is used with a sign instead. This is because different adjustment methods are necessary in the case of positive and negative values of the indicator, i.e. in the case of surplus FX assets and surplus FX liabilities.

Table 4
Adjustment methods of the banks with a FECR of under "–15" per cent, their order, and effects on the indicators

ADJUSTMENT METHOD			EFFECT OF ADJUSTMENT METHOD ON THE INDICATORS			
AM	Asset	Liability	IFR	FFAR	FECR	LCR*
B1	Reduction of forint-denominated liquid assets (government securities)	Reduction of interbank FX-denominated external funds with maturities of 0–1 year (banks and their parent banks swap back the FX loan received from the parent bank and swapped to forints with a local bank, and banks repay the FX loan)	Numerator ↓100% Denominator ↓100%	0	Numerator ↑100% Denominator ↓100%	Numerator ↓100%
B2	FX government bond, central bank bond purchases	Acquisition of interbank FX-denominated external funds with maturities of over 2 years	Denominator ↑100%	Numerator ↑100% Denominator ↑5%	Denominator ↑100%	Numerator ↑100%

*Note: *The exact effect on the outflows and inflows, where relevant, cannot be estimated. The change in the LCR only reflects the change in liquid asset holdings. Also, see the note to Table 2. The red shading indicates deterioration in the indicator, while green denotes improvement. A negative initial value was assumed in the case of the FECR.*

Institutions may face certain balance sheet constraints with the different adjustment methods (*Table 5*). Therefore banks can only use the different methods until the specific balance sheet items are exhausted: for example in method A1, they can only convert their interbank forint-denominated external funds with maturities of 1–2 years to FX as long as they have such funds on their balance sheets. In view of the assumed adjustment methods, there are four balance sheet items that come with constraints, two on the liabilities side, and two on the assets side. There are no balance sheet constraints in the B2 adjustment method and in the A4 method in the first scenario. In the second scenario, besides the constraints in the first scenario, method A4 is constrained too, because it is assumed that banks can only access half the amount necessary from external funds, which calls for an asset-side adjustment.

Table 5
Constraints on the liabilities and assets side of the balance sheet in the case of the different adjustment methods, and their content

Balance sheet constraint		Content and reason	Adjustment method
Liability	Interbank external forint-denominated funds with maturities of 1–2 years and over 2 years	When long-term forint-denominated funds are replaced with long-term FX funds, which can improve the FFAR and the FECR.	A1, A2
	Interbank external FX funds with maturities of 0–1 year	Only the originally short-term interbank FX deposits and outstanding borrowings that are not demand deposits were included, because these are probably the holdings whose maturities can easily be extended by banks.	A3, B1
Asset	Retail FX loans	Including retail FX mortgage loans with real estate collateral (housing and home equity loans) and other retail FX loans.	A5, A6
	Forint-denominated liquid assets	The LCR's numerator was taken into account.	B1

4.2. Compilation of the data, estimation of the indicators

To perform the calculations, the regulatory indicators of the individual banks had to be collected on the one hand, and the balance sheet items triggering the adjustment constraints had to be compiled on the other. The necessary data were derived from the supervisory reporting submitted by the banks. As regards the regulatory ratios, no related reporting was available since the regulations were not in place before the crisis. What is more, a much smaller data set less suited for the estimation of the indicators was available for the period prior to the crisis. Therefore, to tackle the shortage of data and to simplify matters, the indicators could only be approximated, with various specific limitations. The more complex an indicator, the more limitations were needed:

- In the case of the LCR, the main goal was to produce a simpler indicator by capturing the main items.
- With respect to the FFAR, the calculation with original maturities instead of residual maturities, and for some items, estimating the FX ratio and off-balance sheet liabilities due to the lack of data with a currency breakdown posed difficulties.
- With regard to the IFR, the problem was the lack of data on residual maturities and the estimation of the exemptible preferential items in the regulation.
- In the case of liability-side balance sheet constraints, original maturities were used because the residual maturities were not available for the data pertaining to the period before the crisis.

The estimation was made for a smaller set of banks, 13 Hungarian large banks, including major branches. The data were compiled and estimated for all six years between 2003 and 2008. The estimates were produced at the individual (unconsolidated) level, due to simplification and data constraints.

5. Findings

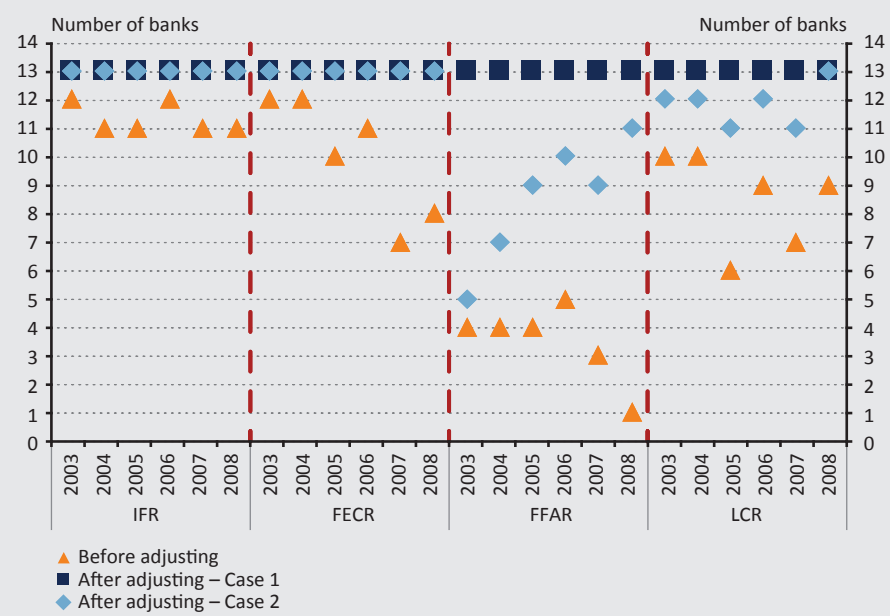
The change and composition of the individual indicators as well as the changes in the short-term interbank external FX funds and retail FX loans in each year and across years were examined by running simulations of the adjustment methods on the compiled data. If some realistic assumptions are met (for example that banks would first mainly adjust on the liabilities side and that at least part of their existing liabilities would be exchanged for long-term FX funds before acquiring them by increasing their balance sheets), minor changes to the ranking of the adjustment methods would not materially influence the results presented here and thus the main conclusions.

5.1. Compliance with regulation

According to the methodology and the adjustment methods described here, all banks under review would have moved closer to the regulatory limits, but not all banks would have achieved full compliance. This would probably have required other adjustment methods that would have made the methodology significantly more complex, and this would not have been reasonable in view of the aim and result of the calculations.

In the first scenario permitting an unlimited liability-side adjustment, all banks would have been able to comply with all ratios in every year (*Figure 4*). In the second scenario complemented with asset-side adjustment, a large portion of banks would have been unable to achieve full compliance by reducing household FX loan holdings due to their limited nature. Therefore, banks would only have been able to improve their ratios. This compliance issue practically only arose in the case of the FFAR. In the early 2000s, the high level of non-compliance is attributable to the fact that retail FX loan holdings were small and building up slowly at that time, corporate FX loans were more typical. Eliminating them suddenly would have had devastating consequences for the operation of banks and the broader economy, therefore this was not included among the potential adjustment methods. It also has to be added that in reality, the introduction of such a regulation is preceded by a long preparation period, which may last for years, giving banks enough time to gradually overhaul even their entire asset and liability structure.

Figure 4
Number of banks complying with regulation before and after adjustment in first and second scenario



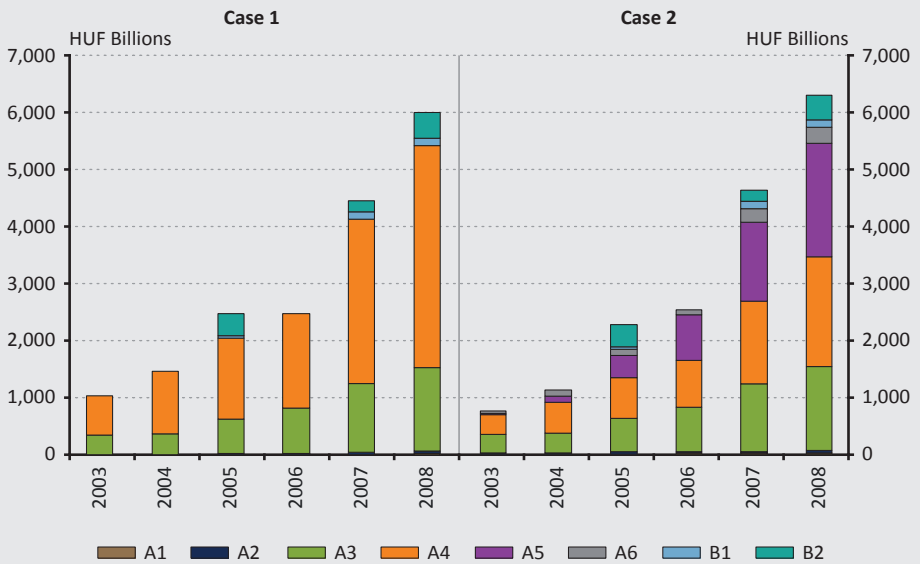
Source: MNB

Since the IFR is even currently preventive and targets extreme banking models, only a few banks, two branches in total, would have been forced to adjust, achieving full compliance. There were no differences between the scenarios, since in the case of the IFR, the compliance with the strictly liability-side requirement cannot be improved with an asset-side adjustment. In the case of the FECR, more and more banks would have been forced to adjust over time, but all banks would have been able to come within the limits in both scenarios. The greatest adjustment would have been required by banks in the case of the FFAR, as almost all banks, with only a few exceptions, would have been forced to adapt. After the adjustment, compliance would only have been achieved by all banks in the first scenario, since the second scenario would have required a major reduction in retail FX loans, and most banks would have been unable to meet the FFAR requirements under such conditions. Most banks would have been able to adjust to meet the LCR requirements, although in the second scenario fewer institutions would have achieved this, because there would have been less room for improving the LCR as the adjustment affected liquid assets less.[14]

According to the results of the backtesting, over time, as the beginning of the crisis approached, banks would have needed to adjust more and more. While the introduction of the regulatory instruments under review would have required only a small adjustment from most banks in 2003, the same would have called for a major adjustment in 2008. Although the use of certain adjustment methods and the exact extent of total adjustment may depend on the methods' ranking, it can be argued that banks would have been able to adjust the most by purchasing government securities from long-term interbank external funds, extending the maturities of short-term external FX funds and, in the case of an asset-side adjustment, by converting retail FX loans into forint (*Figure 5*).

[14] The impact on the development of the indicators and the distribution among banks by regulation is shown in Figures 10–13 of the Annex.

Figure 5
The adjustment and the adjustment methods playing the largest part in it



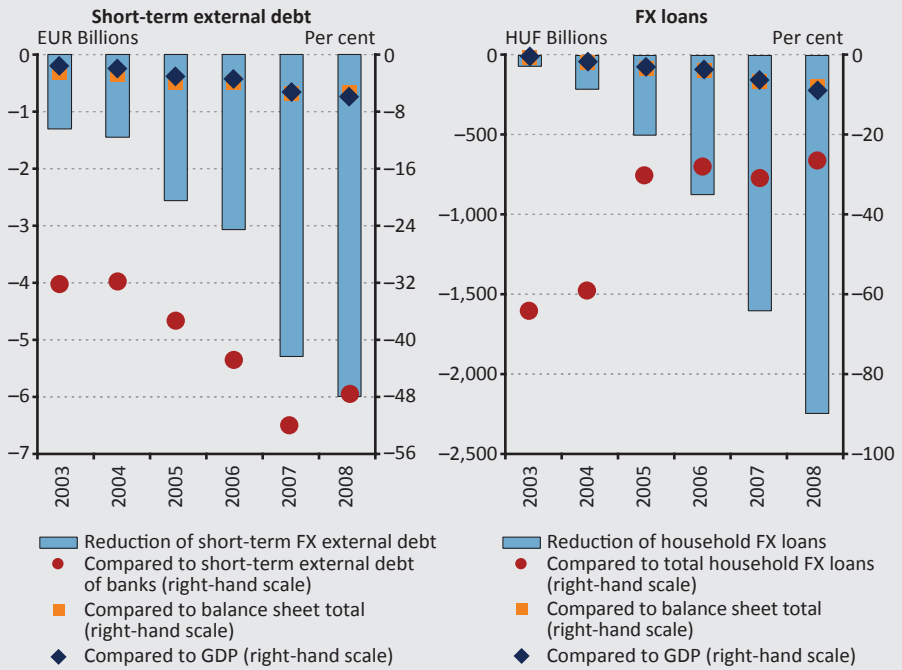
Note: A1: Converting interbank forint-denominated external funds with maturities of 1–2 years to FX; A2: Converting interbank forint-denominated external funds with maturities of over 2 years to FX; A3: Extending the maturities of interbank FX-denominated external funds with maturities of 0–1 year to over 2 years; A4: Purchasing forint-denominated government securities from interbank FX-denominated external funds with maturities of over 2 years; A5: Forint conversion of retail FX mortgage loans; A6: Forint conversion of other retail FX loans; B1: Reducing interbank FX-denominated external funds with maturities of 0–1 year; B2: FX-denominated government bond purchases from FX funds with maturities of over 2 years

Source: MNB

5.2. Effects on external vulnerability and lending

With respect to macroeconomic level effects, if the regulations had been introduced before the crisis, the level of short-term external debt and thus also the external vulnerability of the national economy could have been kept much lower (*Figure 6*). The short-term interbank external debt could have been considerably lower in both scenarios and in all the years under review, especially in the years leading up to the crisis, which would have resulted in lower vulnerability and a much smaller international reserve requirement. With an asset-side adjustment, the contraction in short-term external debt would have been coupled with a massive reduction in outstanding loan portfolio. At the same time, it is important to add that introducing the measures directly before the crisis would have come too late and would have caused a shock, and the cost of compliance would have been high due to the significant adjustment need, which highlights the importance of timing.

Figure 6
Impact of the introduction of the regulation on banks' short-term external debt and FX loans



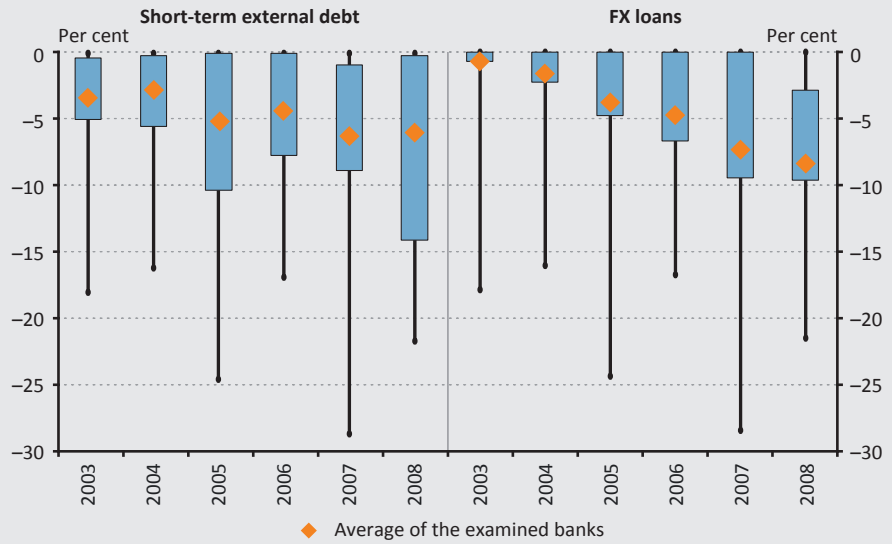
Note: If the instruments had taken effect in the given year. While the reduction in short-term external debt is true for both scenarios, FX loan holdings would only have shrunk in the second case.

Source: MNB

The regulation would have required institutions to cut short-term interbank external FX debt by up to 3–6 per cent of the balance sheet total on average (*Figure 7*), reaching 30 per cent of the balance sheet total at certain institutions, especially in the case of the branches involved in so-called carry trade[15] activities or the business models relying heavily on short-term external funds from the parent bank. Moreover, several banks would have needed to eliminate their entire retail FX loan portfolio. At the time when FX loans started to become popular, the regulation would have required an adjustment amounting to 5–9 per cent of the balance sheet total on average, and this could have been close to 20 per cent in the case of four banks.

[15] These transactions involve asset purchases (or lending for example) from leverage. In the case of an FX market carry trade, borrowing in one currency at lower rates is coupled with an investment (e.g. lending) in another currency at a higher rate.

Figure 7
Change and distribution of short-term external debt and FX loans relative to the balance sheet total

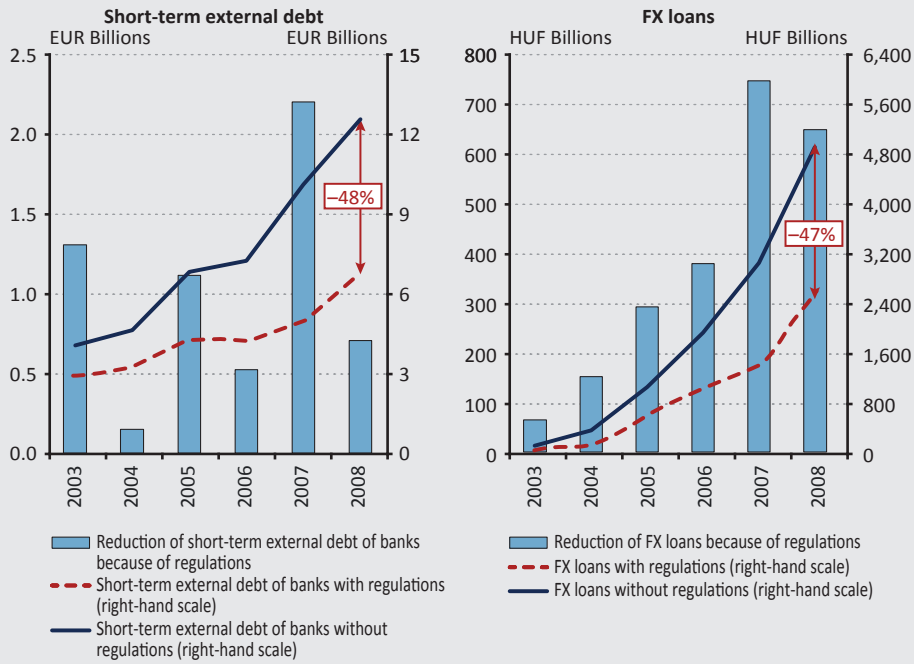


Note: If the instruments had taken effect in the given year. Minimum and maximum, lower and upper quartile values. While the reduction in short-term external debt is true for both scenarios, FX loan holdings would only have shrunk in the second case.

Source: MNB

If the regulation had been introduced by the competent authority in 2003 and it had been maintained in the years after that, it would have crowded out a large amount of short-term external funds, albeit varying quantities in each year, as can be seen from the actual development of short-term external debt (*Figure 8*). The actual credit path suggests that the same would have happened with retail FX loans. However, due to the large spread of forint loans, the FX loans crowded out by the regulation could only have been offset in part by increasing forint loan holdings or by the forint conversion mentioned in connection with the adjustment methods.

Figure 8
Impact of regulation on banks' short-term external debt and FX loans, with a 2003 introduction



Note: The crowded-out holdings for the years show the amount of holdings that would have had to be adjusted in the given year if the instruments had been introduced in 2003. While the reduction in short-term external debt is true for both scenarios, FX loan holdings would only have shrunk in the second case.

Source: MNB.

5.3. Cost estimate in connection with the effects on lending

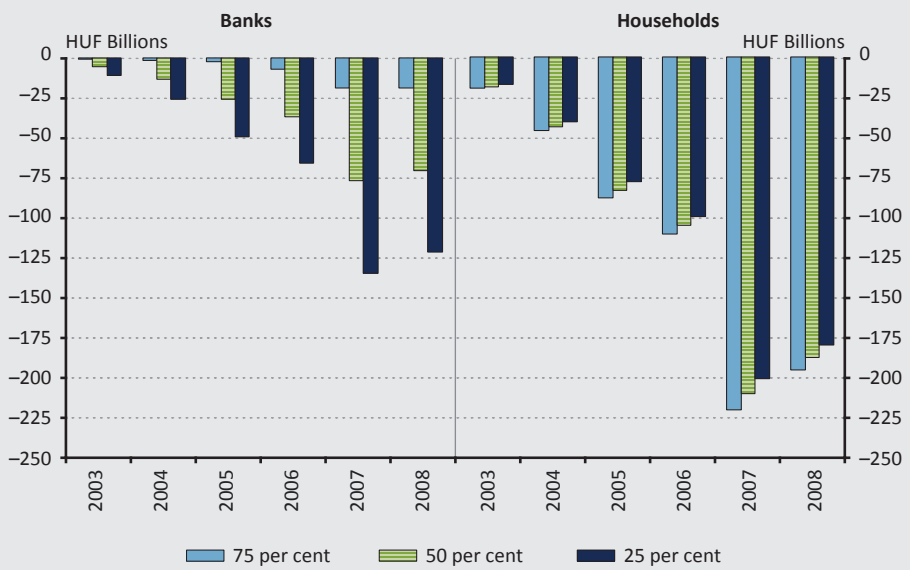
In the case of households, costs were approximated with the rise in the debt servicing burden originating from the difference between forint- and FX-denominated borrowing rates, while in the case of banks, the lost debt servicing related to the lost FX loan holdings was used. In the case of the annual adjustment requirement, the annual amount of debt servicing and lost debt servicing was estimated with converting to forint loans to various degrees. The average maturity used in the calculation was 10 years. The formula used to estimate the debt servicing burden was as follows (based on *Dynan et al. 2003*):

$$DS_t = D_t \cdot \frac{i_t}{(1-(1+i_t)^{-s_t})},$$

where DS_t is the debt servicing rate in the period t, D_t is the outstanding debt, i_t denotes the average annual interest rate and s_t stands for the average annual residual maturity of the outstanding debt.

Large and growing surplus costs would have been incurred by banks mainly because of the potentially lost loans, and by households because of the large spread on forint loans, depending on the size of the FX loan holdings to be reduced and the assumed extent by which forint conversion can be performed (*Figure 9*).

Figure 9
Costs of banking system and households in case of FX loan forint conversions, under different scenarios



Note: In the case of the annual adjustment requirement, the annual amount of debt servicing (DS) for households and lost debt servicing for banks, with refinancing through various amounts of forint loans, assuming a 10-year average loan maturity. Crowded-out FX loans in the case of the regulation used in the previous year, with proportionate refinancing.

Source: MNB

Although the calculation above is admittedly a mere approximation, it has to be noted that these costs would probably have been much lower than the losses realised by households and the banking system in connection with the undertaken exchange rate risk and credit risk, related to the unsustainable banking model, as well as the spillover costs for the national economy, which are well-known to have been high. In the case of the Swiss franc-denominated loans, which comprised the overwhelming majority of household FX loans, on account of the Swiss franc's 60-per cent appreciation against the forint between 2008 and November 2014 when the technical forint conversion took place, a revaluation effect amounting to around HUF 1,400 billion may have taken hold in connection with the FX loans shown by our estimate to have been crowded-out by the end of 2008, amounting to roughly HUF 2,300 billion, with regard to the change in repayment instalments at that time

and the remaining principal in 2014.[16] In other words, the early introduction of the regulation would have saved the public this much in losses, which in itself is many times higher than the households' and banks' estimated losses combined. The regulations would have reduced excessive risk-taking by banks and households by internalising risks.

6. Summary

Building on the experiences from the 2008 global financial crisis, the MNB devised a comprehensive set of rules, mainly comprising regulations managing currency mismatches and short-term liquidity. To gain a rough picture about the extent by which these reduce the vulnerability of the banking system and thus also the economy, it was examined what impact the pre-crisis implementation of the above-described rules would have had. The backtesting calculation suggests that the liquidity and funding regulations introduced since 2012 would have considerably mitigated the vulnerability of individual banks, the banking sector as a whole and the entire national economy, had they been implemented before the crisis.

With respect to compliance with the regulations, in the case of a liability-side adjustment only, all banks would have improved their ratios, achieving full compliance. However, when the liability-side adjustment is constrained and an asset-side adjustment is permitted, about half of the banks would have been unable to meet all the requirements by relying only on the adjustment methods that were deemed easy to implement and proportionally cost-effective. In all cases, banks would have been forced to adjust the most by the FFAR: in the case of an asset-side adjustment, this would have been the least likely to be met by banks.

The backtesting results show that the short-term interbank external debt would have been substantially lower in all scenarios, which would have translated into considerably lower vulnerability and a smaller international reserve requirement. With an asset-side adjustment, the volume of retail FX loans should have contracted as well through forint conversion, or it would have been unable to build up in the first place, due to the regulatory constraints. These adjustments would have materially improved the stability of the financial system, thereby mitigating the national economy's vulnerability. Finally, the analysis described here also underlines the significance of timing. The costs associated with the adjustment would probably have been much lower than the losses arising from the flawed funding and lending practices. Nevertheless, if the measures had been introduced in 2008, the necessary adjustment would have meant a shock to the banking system. However, this would have been avoidable with an appropriately communicated and timely introduction.

[16] The increased burden caused by the higher interest rates on forint loans was already taken into account among the costs of the regulation.

This analysis backtested the MNB's current liquidity and funding instruments to show that the applied rules can effectively forestall the financial stress observed in crises, for example in the wake of the present coronavirus pandemic. The rules under review may prevent banks from their over-reliance on short-term, mainly external FX funds, funds from financial corporations or off-balance sheet derivative transactions, which are considered riskier. So based on this analysis, one may argue that the tested instruments would have been able to mitigate the risks associated with excessive FX lending and the high costs incurred by the national economy in connection with this, by internalising the costs of these funding practices paid by households and the banking system.

References

Acharya, V. – Schaefer, S. (2005): *Understanding and managing correlation risk and liquidity risk*. International Financial Risk Institute (IFRI) Roundtable, 29–30 September.

Balás, T. – Móré, Cs. (2007): *Likviditási kockázat a magyar bankrendszerben* (*Liquidity risk in the Hungarian banking system*). MNB-tanulmányok 69, Magyar Nemzeti Bank, December. https://www.mnb.hu/letoltes/mt-69.pdf

BCBS (2000): *Sound practices for managing liquidity in banking organisations*. Basel Committee on Banking Supervision, February. https://www.bis.org/publ/bcbsc135.pdf

BCBS (2009): *Findings on the interaction of market and credit risk.* Working Paper Series No. 16., Basel Committee on Banking Supervision, May. https://www.bis.org/publ/bcbs_wp16.pdf

BCBS (2013): *Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools.* Basel Committee on Banking Supervision, January. https://www.bis.org/publ/bcbs238.pdf

BCBS (2014): *Basel III: the net stable funding ratio*. Basel Committee on Banking Supervision, October. https://www.bis.org/bcbs/publ/d295.pdf

Baudino, P. – Sturluson, J.T. – Svoronos, J-P. (2020): *The banking crisis in Iceland.* FSI crisis management series No. 1, Bank for International Settlements. https://www.bis.org/fsi/fsicms1.pdf

Brunnermeier, M.K. – Pedersen, L.H. (2007): *Market Liquidity and Funding Liquidity*. NBER Working Paper No. 12939, National Bureau of Economic Research. https://doi.org/10.3386/w12939

Csávás, Cs. (2015): *A devizatartalék-megfelelés értékelésének nemzetközi trendjei* (*International trends of assessing FX reserves adequacy*). Szakmai cikk (Article), Magyar Nemzeti Bank, June. https://www.mnb.hu/letoltes/csavas-csaba-a-devizatartalek-megfeleles-ertekelesenek-nemzetkozi-trendjei.pdf. Downloaded: 10 March 2020.

Dell'Ariccia, G. – Deniz, I. – Lae ven, L.A. (2012): *Credit booms and lending standards: Evidence from the subprime mortgage market.* Journal of Money, Credit and Banking, 44(2–3): 367–384. https://doi.org/10.1111/j.1538-4616.2011.00491.x

Demyanyk, Y. – Hemert, O. Van (2011): *Understanding the Subprime Mortgage Crisis*. Review of Financial Studies, 24(6): 1848–1880. https://doi.org/10.1093/rfs/hhp033

Dudley, W. (2014): *Welcome remarks*. President and Chief Executive Officer of the Federal Reserve Bank of New York, at the workshop on the "Risks of Wholesale Funding", New York City, 13 August.

Dynan, K. – Johnson, K. – Pence, K. (2003): *Recent changes to a measure of US household debt service*. Federal Reserve Bulletin, 89(10): 417–426.

ECB (2002): *Developments in bank's liquidity profile and management*. European Central Bank, May. https://www.ecb.europa.eu/pub/pdf/other/banksliquidityprofile02en.pdf

ECB (2010): *Financial stability review*. European Central Bank, June. https://www.ecb.europa.eu/pub/pdf/fsr/financialstabilityreview201006en.pdf

Fábián, G – Vonnák, B. (eds.) (2014): *Átalakulóban a magyar bankrendszer. Vitaindító a magyar bankrendszerre vonatkozó konszenzusos jövőkép kialakításához* (*Hungarian banking system in transition. A keynote paper for developing a consensus-based vision for the Hungarian*). MNB-tanulmányok 112., különszám, Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/mt112-kulonszam.pdf

Hahm, J.H. – Shin, H.Y. – Shin, K. (2013): *Non-Core Bank Liabilities and Financial Vulnerability*. Journal of Money, Credit and Banking, 45(s1): 3–36. https://doi.org/10.1111/jmcb.12035

Hartmann, P. (2010*): Interaction of market and credit risk*. Journal of Banking and Finance. 34(4): 697–702. https://doi.org/10.1016/j.jbankfin.2009.10.013

Huang, R. – Ratnovski, L. (2011): *The dark side of bank wholesale funding*. Journal of Financial Intermediation, 20(2): 248–263. https://doi.org/10.1016/j.jfi.2010.06.003

Hungarian Financial Supervisory Authority (HFSA) (2013): *Risk report* 2013/I. Hungarian Financial Supervisory Authority, June.

Iyer, R. – Peydró, J-L. (2011): *Interbank contagion at work: Evidence from a natural experiment.* The Review of Financial Studies, 24(4): 1337–1377. https://doi.org/10.1093/rfs/hhp105

Nagy, M. – Szabó, E.V. (2008): *The Sub-prime Crisis and its Impact on the Hungarian Banking Sector*. MNB Bulletin, 2008(April): 35–43. https://www.mnb.hu/letoltes/mnb-bull-2008-04-marton-nagy-viktor-e-szabo-en.pdf

Nagy, M. – Palotai, D. (2014): *A devizatartalék óvatosan csökkenthető* (*FX reserves may be reduced cautiously*). Szakmai cikk (Article), Magyar Nemzeti Bank, April. https://www.mnb.hu/letoltes/a-devizatartalek-ovatosan-csokkentheto-2014-04-22.pdf. Downloaded: 6 April 2020.

Nagy M. – Vonnák, B. (2014): *Egy jól működő magyar bankrendszer 10 ismérve* (*10 features of a well-functioning Hungarian banking sector*). Szakmai cikk (Article), Magyar Nemzeti Bank, March. https://www.mnb.hu/sajtoszoba/hirek-2015-juniusig/nagy-marton-vonnak-balazs-egy-jol-mukodo-magyar-bankrendszer-10-ismerve. Downloaded: 10 April 2020.

Páles, J. – Kuti, Zs. – Csávás, Cs. (2010): *The role of currency swaps in the domestic banking system and the functioning of the swap market during the crisis.* MNB Occasional Papers 90, Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/op-90.pdf

Poghosyan, T. – Čihák, M. (2009): *Distress in European Banks: An Analysis Based on a New Data Set.* IMF Working Paper No. 09/9. https://doi.org/10.5089/9781451871562.001

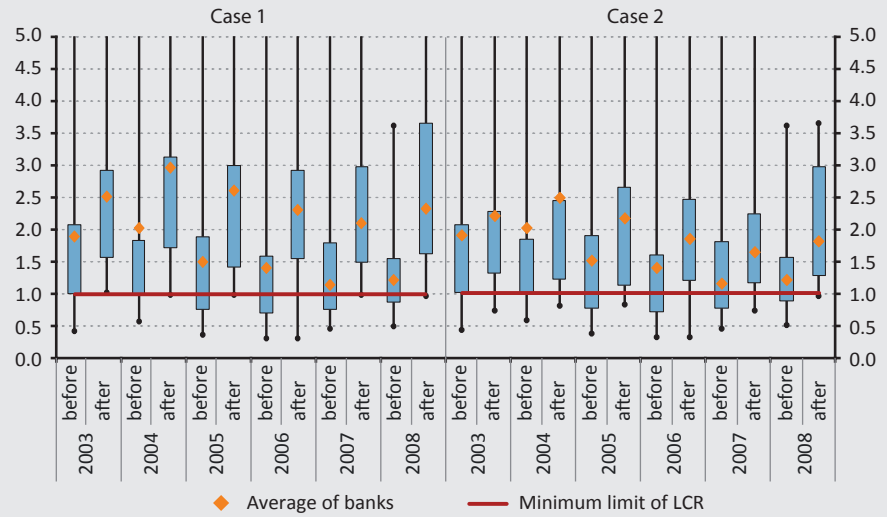
Ratnovski, L. – Huang, R. (2009): *Why Are Canadian Banks More Resilient?* IMF Working Paper No. 09/152. https://doi.org/10.5089/9781451872996.001

Sharma, P. (2004): *Speech on liquidity risk*. Financial Services Authority, London, October.

Yorulmazer, T. – Goldsmith-Pinkham, P. (2010): *Liquidity, Bank Runs, and Bailouts: Spillover Effects During the Northern Rock Episode*, Journal of Financial Services Research, 37: 83–98. https://doi.org/10.1007/s10693-009-0079-2

Annex

Figure 10
Distribution of banks' initial and post-adjustment LCR values by years

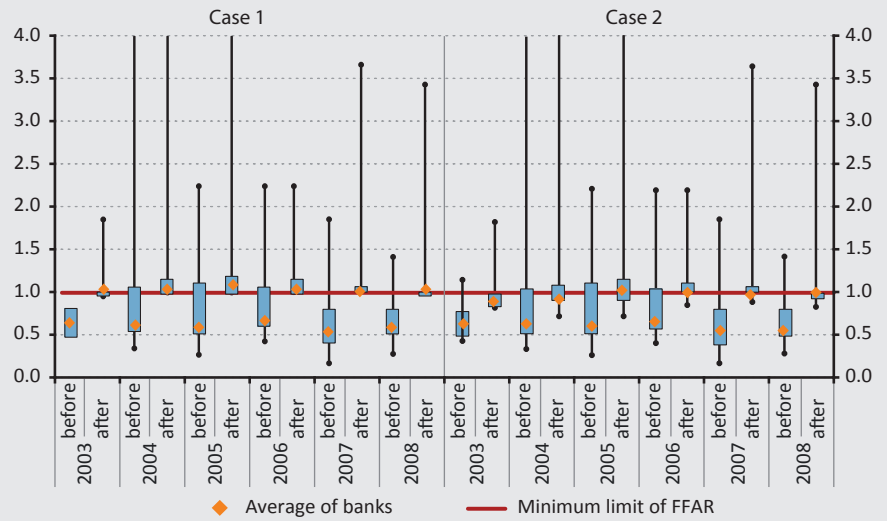


Note: The chart shows the minimum and maximum values, the first and third quartile and the average.
Source: MNB

Figure 11
Distribution of banks' initial and post-adjustment FECR values by years

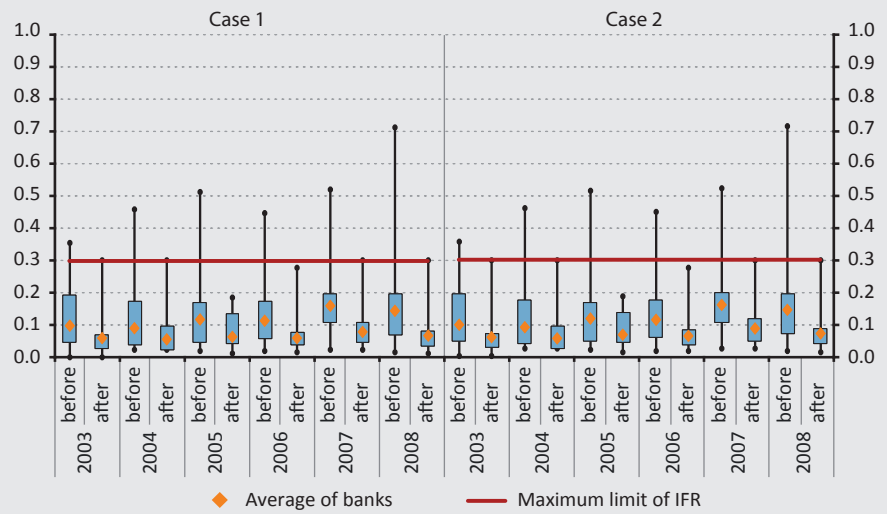
Note: The chart shows the minimum and maximum values, the first and third quartile and the average.
Source: MNB

Figure 12
Distribution of banks' initial and post-adjustment FFAR values by years



Note: The chart shows the minimum and maximum values, the first and third quartile and the average.
Source: MNB

Figure 13
Distribution of banks' initial and post-adjustment IFR values by years



Note: The chart shows the minimum and maximum values, the first and third quartile and the average.
Source: MNB

Analysis of the Export Activity of Hungarian FinTech Companies*

Péter Fáykiss – Lívia Ónozó

In our analysis, we examine domestic FinTech SMEs by using micro-data, focusing on the export activity of companies in the Hungarian FinTech sector. Our study offers new content not only because of the range of examined enterprises, but also due to the uniqueness of the database used, as we have endeavoured to provide a deeper picture of domestic FinTech companies with the help of company data rarely used thus far. The purpose of our examination is twofold: first, based on the company characteristics that can be extracted from the annual accounts of the companies concerned, we organise the Hungarian FinTech companies into distinct groups by cluster analysis. Second, using logistic regression estimation on the cross-sectional data, we identify the most important factors affecting the export activity of domestic FinTech companies. Our results have shown that FinTech companies active in Hungary can be divided into three distinct clusters based on the company characteristics involved: export share, headcount and various financial indicators. Regarding the three clusters, medium-sized companies make up half of the cluster in the group of FinTech companies with the highest export share, and the group is characterised by high value added relative to balance sheet totals. Based on our logistic regression estimation, among the FinTech companies we examined, a significantly positive effect on the probability of exporting can be identified in the case of value added, headcount and foreign ownership.

Journal of Economic Literature (JEL) codes: G23, G3, L26, O33

Keywords: FinTech, export, cluster analysis

1. Introduction

Digital financial services are becoming an increasingly vital part of modern financial systems. The FinTech sector is also growing dynamically on a global scale: it is characterised by more and more customers and an ever-wider range of products. This trend is reinforced by special demand, supply and technology factors as well

* 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 Hungarian manuscript was received on 16 June 2020.

DOI: http://doi.org/10.33893/FER.19.4.6082

(*MNB 2020*). To many people, FinTech companies today still appear primarily as end-user, consumer service enterprises, but it is becoming increasingly apparent that a significant group of them are basically serving business users and other enterprises.

In this study, the term "FinTech" is essentially used according to the definition of the Financial Stability Board (FSB)[1] (*FSB 2017*), i.e. FinTech companies are considered to be enterprises providing technology-oriented innovations that result in new business models, applications, processes or products with an material impact in the financial services sector. Thus typically, they are technology-focused enterprises that either provide some kind of technological solution in an element or elements of the value chain for financial services institutions, or provide services for end-users in connection with a financial product. However, this does not necessarily mean it can only be a service that can be provided with supervisory permission. There are several areas where FinTech companies provide services that are not subject to permission. Different definitions can of course be found in academic literature (see, among others, *Arner et al. 2015* or *Kim et al. 2016*). In our analysis, we have considered the increasingly dominant FSB definition to be the guiding principle.

According to data of the Central Bank of Hungary (Magyar Nemzeti Bank, MNB), in 2018 there were more than 110 FinTech companies in Hungary. The domestic FinTech sector employed about 5,000 people based on the data of 2018 accounts, and their total annual revenue was close to HUF 120 billion. The vast majority of these companies basically provided a "business to business" service, i.e. they focused primarily on business customers. The profitability of the entire sector was high, mainly due to larger, often foreign-owned enterprises. The sector has seen strong growth in recent years, with both revenue and the number of employees increasing substantially (*MNB 2020*). Although the current size and national economic weight of the domestic FinTech sector (below 5 per cent) is dwarfed compared to the entire financial, insurance and information-communication sections[2], it can still be considered an important segment for two reasons. First, these companies often have high value added and thus they may be able to engage in significant export activity, which can be a key factor for growth. Second, the competitive technological solutions they use can not only improve their own efficiency, but by becoming integrated into the value chain of financial services, they can also strengthen and catalyse the competitiveness of the entire domestic financial system, which can also have a positive impact on economic growth through lending and other financial services.

[1] *"FinTech is defined 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*).
[2] STADAT – 3.1.4. Value and distribution of gross value added by industries (1995–). https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_qpt002d.html

In the context of the FinTech phenomenon, international academic literature focuses primarily on the main driving forces in relation to the field and the potential challenges to the financial system (see, among others, *Arner et al. 2015; King 2014; Lee – Shin 2018; Varga 2017;* and a useful summary about the FinTech field and possible future research directions: *Goldstein et al. 2019*). Another important direction in literature is the aspect of regulation for FinTech companies and its policy implication (e.g. *Douglas 2016*; *Anagnostopoulos 2018*; *Buchak et al. 2018*; *Fáykiss et al. 2018*; *Müller–Kerényi 2019*). Only a smaller part of research deals with a deeper, country-focused analysis of FinTech companies (e.g. *Bhandari 2016*; *Jutla – Sundararajan 2016*), and an even smaller part uses micro-level data, in most cases due to the lack of appropriate databases. In the latter area, the study by *Gai et al.* (*2018*) focuses on the Chinese FinTech ecosystem, while *Gazel – Schwienbacher* (*2020*) examine the formation of geographic clusters by using data from about 1,000 French FinTech companies. In addition, it is worth mentioning the analysis by *Eickhoff et al.* (*2017*) and that by *Gimpel et al.* (*2018*). The former identified different FinTech business models based on micro-level data, while the latter carried out a taxonomy of FinTech companies with a "business to customer" focus by using a combination of quantitative and qualitative methodologies.

In our analysis, we examine domestic FinTech small and medium-sized enterprises by using micro-level data, focusing on a less well-known but rather important dimension of the domestic FinTech sector: the export activity of these enterprises. The purpose of our analysis is firstly to identify and briefly describe the distinct groups of domestic FinTech companies on the basis of different company characteristics (headcount, export activity, financial data), taking into account their export activity, and secondly, by using regression estimations on cross-sectional data, to identify the most important factors affecting the export activity of domestic FinTech companies and the relative role of these factors.

The examination of the export activity of domestic FinTech SMEs is relevant because, although Hungary is very active in foreign trade, the proportion of domestic value added in exports is moderate. Domestic exports are concentrated in a relatively limited range, typically in large companies, and products competitive in external markets are highly dependent on the imported goods used. The SME sector accounts for only about 20 per cent of Hungary's foreign trade turnover, while a significant reserve can be identified for increasing the number of exporting SMEs (*MNB 2019*). The MNB's Competitiveness Programme proposed that the goal should be to increase the number of exporting SMEs by a further 10,000 from the current 32,000, and to increase the domestic value-added content of exports substantially. Increasing export activity is one of the most obvious growth opportunities for a FinTech company; the cross-border sale and provision of typically online, technology-based services is feasible – especially for companies with a business-to-business model –, while the global market for financial services

offers a huge opportunity (see, among others, *MNB 2020*; *Dietz et al. 2015*; *Arner et al. 2015*; *Lee – Shin 2018*; *Gimpel et al. 2018*).

Companies producing for the export market face a number of challenges, and this is especially true for small and medium-sized enterprises. The decision about whether a company enters the export market is very much a managerial decision on the one hand, which financial variables are often less able to capture (see, for example, *Miesenblock 1988*; *Bijmolt – Zwart 1994*). On the other hand, however, it is essential for the given company to have a certain level of productivity and value-added to be able to cover any additional costs associated with exports (in this regard, see *Melitz 2003*, among others). Although this element is typically present in the case of FinTech companies using relatively advanced technology, we will show later that this factor is important in this segment as well in terms of the evolution of export activity. In our study, using a database that can be considered quite unique, we attempt to get to know the factors driving the export activity of domestic FinTech companies, to determine the dimensions specific to the group of domestic FinTech companies with stronger export activity, and we identify the relative role of these factors. The main contribution of our study is offering a detailed analysis of the clustering of domestic FinTech SMEs, taking export activity into account as well, and identifying the most important factors affecting the export activity of domestic FinTech SMEs by using logistic regression estimation on the cross-sectional data available to us.

In the *next part* of our study, we briefly describe how the examined domestic FinTech companies were identified and how our examined sample was put together. In the *third part*, we briefly review the range of data used, while in the *fourth*, we present the examined variables for domestic FinTech small and medium-sized enterprises. In the *fifth part* of our study, we briefly present whether, in the case of Hungarian FinTech enterprises, a relationship between the ownership structure and the service ranges of these FinTech companies can be identified. After that, we perform a cluster analysis of domestic FinTech companies with special regard to the export activity of the examined companies. In the *seventh part*, we identify the most important factors affecting the export activity of domestic FinTech companies and the relative role of these factors. The *final part* of the study contains the conclusions.

2. Identification of domestic FinTech companies

In order to carry out a deeper analysis of the export activity of Hungarian FinTech companies, it is important to identify companies that can be considered domestic FinTech companies. In our analysis, we used the definition developed by the Financial Stability Board to determine the range of services considered FinTech. As indicated above, according to the FSB's relatively broad definition, FinTech comprises financial-related services based on technology solutions that result in

new business models, processes, applications or products (*FSB 2017*). Such activities include, among others, mobile banking, investment advisory via digital platforms, blockchain-based solutions, cryptocurrencies, cybersecurity and other technology solutions in financial fields, financial software development and system integration.

When compiling our examined sample, we only took into account companies registered in Hungary with a Hungarian tax number. From these, based on the NACE II classifications, companies with core activities of information technology and information services, registered as partnerships in Hungary, can constitute the basis for identifying FinTech companies. In 2019, we found roughly 15,000 enterprises engaged in such activities. Their websites were located with the help of Bing Web Search and Google Search API (for more details on the identification method used, see *MNB 2020, Box 3*). In addition to these NACE II classifications, the possibility of using other ones (e.g. management consulting services, auditing activity, other technical activities) may arise, but on the one hand they are related to FinTech activities on a much more distant basis, and on the other hand, domestic companies typically have several NACE II classifications. Thus the number of FinTech enterprises that may have been omitted due to the collection based on a somewhat narrower NACE II classification is quite low, also bearing in mind that, during the collection, other sources of information were used as well to check for any missing FinTechs (CB Insights, Crunchbase).

By collecting terms related to FinTech services, a database in English and Hungarian was compiled. In the corpus formed from the text of the websites found relevant and then collected, the results can be ranked according to the frequency of occurrence of the terms (adjective-noun structures) in the database. Based on the websites with the best results, a list of companies with some 300 items can be generated, of which about 110 FinTech enterprises can be identified in Hungary after filtering for the activity meeting the definition of *FSB* (*2017*) (*MNB 2020*).

3. Range of data used in the analysis

As indicated above, the database we used only contained enterprises with a Hungarian tax number. To ensure our analysis would not be distorted by larger companies that may have been active even in several service areas, from the identified FinTechs we filtered out the companies that could not be classified as micro-, small and medium-sized enterprises. The size of the companies was based on the composite classification established in practice, i.e. by taking into account the limits for balance sheet total, revenue and headcount. To define company size categories, we applied the definition used by the European Commission[3], i.e. we took into account the following thresholds for balance sheet total, revenue and

[3] See details: https://op.europa.eu/en/publication-detail/-/publication/79c0ce87-f4dc-11e6-8a35-01aa75ed71a1

headcount: micro-sized enterprises are those that employ fewer than 10 people and whose annual turnover or balance sheet total does not exceed EUR 2 million; small enterprises are those with between 10 and 49 employees, and up to EUR 10 million in revenue or balance sheet total; while medium-sized enterprises are companies with less than 250 employees and annual revenue of less than EUR 50 million or a balance sheet total of less than EUR 43 million.

In our analysis, from the companies in the domestic FinTech sector, we took into consideration the micro-, small and medium-sized enterprises that were active in 2019. Following the data filtering indicated above, our database contained a total of 104 companies. FinTech companies active in Hungary were basically examined in light of their annual accounts. This made it possible for us to analyse the economic activity and size of companies, and within the FinTech sector, to identify distinct groups taking export activity into account as well. Where data may have been incomplete in the annual accounts, we also used the OPTEN company directory as a secondary database. Generally speaking there were essentially no extreme outliers in the analysed database, but if outliers occurred for a given variable, this is indicated separately at the given place.

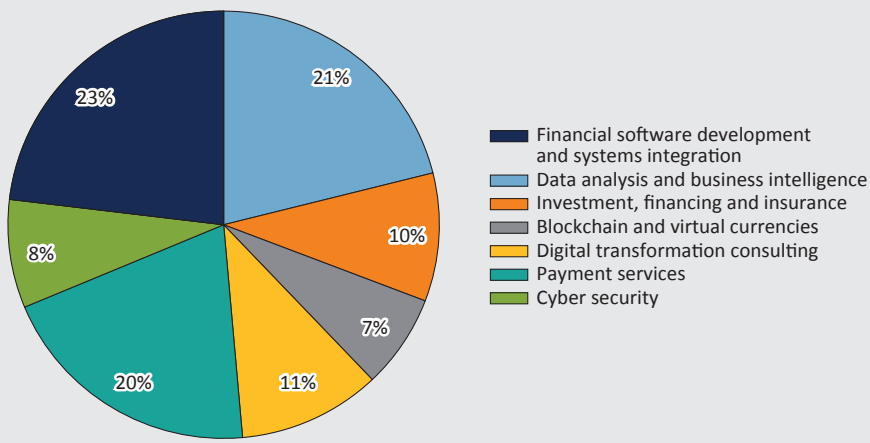
4. Variables examined for domestic small and medium-sized FinTech enterprises

Based on their activities and annual accounts, FinTech companies included in the examination were essentially examined based on 10 variables, which in our view cover the most important dimensions of these companies as well as possible in light of the available data. As categorical variables, (i) the ownership background (domestic or foreign), (ii) the business focus ("business to business" or "business to customer") and the broader (iii) range of services of the given enterprise were included in the analysis. An enterprise was considered foreign-owned if the foreign ownership exceeded 50 per cent of the equity. The main business focus and main range of services of FinTech enterprises were established on the basis of NACE II numbers and the given enterprise's website. In our analysis, as numerical variables, we used (iv) exports relative to total revenue, (v) the number of employees, indicating the size of the company, (vi) equity and (vii) short-term debt relative to the balance sheet total, which capture the equity ratio, (viii) the ratio of liquid funds to the balance sheet total, showing liquidity conditions and (ix) the after-tax return on sales revenue, indicating profitability, while as a variable capturing value added, (x) the ratio of personnel expenses, depreciation and amortisation and after-tax profit to the balance sheet total was used. In our cluster analysis, we basically used these numerical variables.

Regarding the examination of categorical variables, domestic FinTech companies cover a rather wide range of services. Of the seven categories used, most of the FinTech enterprises in the sample are mainly active in the *"Data analysis*

and business intelligence", the *"Payment services"* and the *"Financial software development and system integration"* service categories (*Figure 1*). Looking at the sampled FinTech companies according to their ownership background, we can see that about 73 per cent of them can be considered Hungarian-owned, while 27 per cent of them are foreign-owned companies. Although our variable based on the proportion of foreign ownership within the company can be measured on a continuous scale, the observations are typically around 0 and 100 per cent, which enabled classification into domestic and foreign groups. In addition, due to the concentration around the two extremes, cutting at 50 per cent does not cause any distortion in the data. Finally, based on the main business focus, the vast majority of domestic FinTech SMEs, about 85 per cent, are basically "business to business" enterprises, i.e. essentially offer services to other enterprises, and only 15 per cent of them provide primarily "business to customer" services, i.e. services focused on end-users and consumers. It is worth noting that, both in terms of service range and ownership background, as well as main business focus, the distributions in the FinTech sample narrowed down by us to small and medium-sized enterprises differ only slightly from the distributions observed over a wider range of data in the FinTech and Digitalisation Report (*MNB 2020*).

Figure 1
Distribution of number of domestic small and medium-sized FinTech enterprises by service range



Sources: National Tax and Customs Administration, MNB

The most important descriptive statistics of the numerical variables used in our analysis are presented in *Table 1.* In terms of the export ratio, the examined companies are characterised by a significant standard deviation: although the average ratio is about 32 per cent, the median is only 5 per cent and the standard deviation is 40 per cent. As for the export ratio distribution, there are essentially two

extremes: the very low export ratio below 10 per cent (typically smaller enterprises) and the very high export activity of up to even more than 90 per cent (*Figure 2*). Unfortunately, the database available did not contain information on the direction and depth of export activity, and thus for the FinTech companies examined there is no data on which countries, exactly how many types and what products are exported and whether entries to an export market and exits therefrom can be identified.

In terms of headcount, the average is 30 people, the standard deviation is 43 people, while half of the companies in our sample have more than 13 employees, so in line with our expectations, there are many smaller start-ups. The ratio of equity, short-term debt and liquid funds to the balance sheet total shows that the examined FinTech companies basically finance themselves from equity and typically have a financing and liquidity policy that can be considered conservative, although substantial extremes can also be identified in this area. With regard to the profit relative to revenue, it can be concluded that a notable number of the companies make losses, as the average is around –14.5 per cent. Since there are a lot of smaller start-up FinTech enterprises in the sample, this is not so surprising. Moreover, interestingly, the median is 7.5 per cent, i.e. half of the companies are already generating a substantial profit relative to revenue, with a significant standard deviation of course. Finally, we can also see a remarkable standard deviation for the variable used as an element to capture value added, produced from the ratio of personnel expenses, depreciation and amortisation and after-tax profit to the balance sheet total. Nevertheless, both the average (about 79 per cent) and the median value (61 per cent) suggest that a significant part of domestic FinTech SMEs can generate substantial value added.

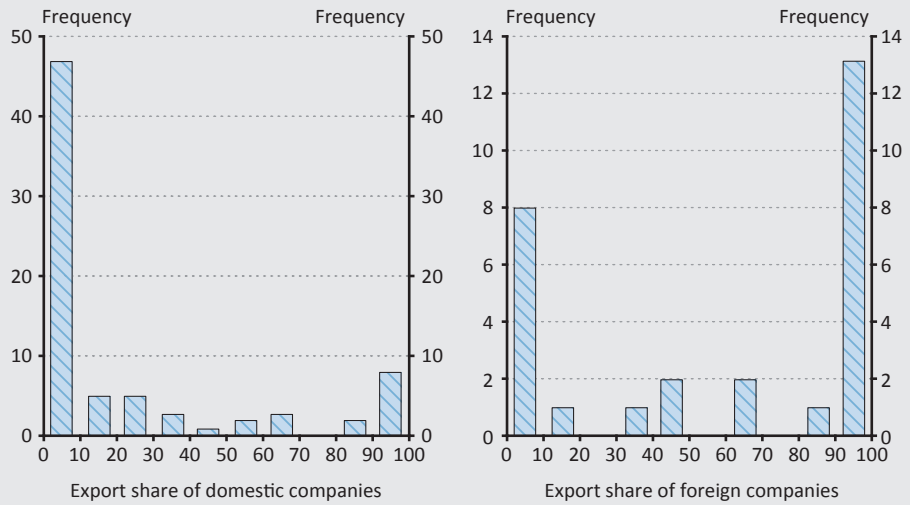
Table 1
Descriptive statistics of domestic FinTech companies in the sample

	Average	Standard deviation	Median	Minimum	Maximum
Export ratio (%)	31.88	40.11	5.36	0	100
Headcount (persons)	29.97	43.10	13.00	1.00	236.00
Ratio of equity to balance sheet total (%)	48.95	29.36	50.15	–52.22	98.65
Ratio of short-term debt to balance sheet total (%)	36.88	24.20	31.86	1.32	97.88
Ratio of liquid funds to balance sheet total (%)	33.51	28.77	24.01	0.11	97.58
Profit relative to revenue* (%)	–14.57	102.89	7.49	–665.65	75.93
Value added (%)	78.83	86.86	60.87	–63.17	429.83

Note: When compiling descriptive statistics for the variable marked with an asterisk, an enterprise qualifying as an outlier was not considered.

Sources: National Tax and Customs Administration, MNB

Figure 2
Distribution of export revenue share of domestic and foreign-owned FinTech companies



Sources: National Tax and Customs Administration, MNB

5. Ownership background and range of services

Below, we briefly review whether FinTech enterprises with different ownership backgrounds can be more active in certain service ranges. We basically relied on cross-table analysis here. We examined the relationship between the two categorical variables with a Chi-square test. Since the cross-table analysis of the FinTech companies in our sample had fewer than 5 observations in about 28.6 per cent of the cells, we also used the Fischer Exact test for the analysis, which is more applicable for a smaller number of elements.

Based on the Chi-square and the Fischer Exact tests, at a significance level of 5 per cent we can conclude there is no significant relationship between the ownership background and the service range (*Table 2*). A similar result can be seen in light of the Phi and Cramer V tests: no significant relationship between these categorical variables can be identified (see *Annex*). So in view of this, no significant relationship between the ownership background and the service range for domestic FinTech SMEs in our sample can be detected, i.e. in the case of foreign majority-owned FinTech companies operating in Hungary, there is a similar distribution of activity in the service ranges as in the case of domestically-owned FinTechs.

Table 2
Results of Chi-square and Fisher Exact tests for the relationship between ownership background and service range of domestic FinTech SMEs

	Value	df	Asymptotic sig. (2-sided)	Exact sig. (2-sided)
Pearson Chi-square test	4.279[a]	6	0.592	0.639
Fischer Exact test	4.545			0.619
N	104			

Note: a) In 4 cells (28.6%), there are fewer than 5 observations. For both tests, the null hypothesis assumes that the two variables are independent.

6. Cluster analysis of domestic FinTech SMEs

After presenting the examined variables and examining the relationship between the ownership background and the service range, we performed a cluster analysis among the domestic small and medium-sized FinTech enterprises to identify the most important groups of domestic FinTech companies, based on different examined variables, especially the companies' export activity. In the cluster analysis, our intention is that, based on the different variables, the variance within the clusters should be as low as possible, while the variance between the clusters should be high. During cluster analysis, we have no a priori information about the observation groupings. We consider a cluster good if the companies in each group are similar, while they differ markedly from the elements of another group. In this case, by including data obtained from the companies' annual accounts, we would like to get an idea of how domestic FinTech companies can be grouped, especially with regard to their export activity.

As we are dealing with an exploratory analysis here, it is important to note that no general conclusion can be drawn from our sample about the population. What cluster a company falls into depends largely on the procedure chosen, and thus there are many other solutions besides the ones we have described. In our analysis, we performed clustering with the help of the K-means partitioning algorithm and hierarchical cluster analysis. In the case of the K-means analysis, the optimal number of clusters was determined by the so-called "elbow" method, in which the variances within the groups were compared with the variance between the groups for the different cluster numbers. The quotients thus obtained are called "cluster elbow" indicators. By plotting them as a function of cluster numbers, the optimal cluster number can be identified based on the greater slope change of the indicator. In addition to minimising proximity (i.e. variance) within the clusters and maximising distance between the clusters, the definition of three clusters was considered optimal.

For the variables included in the cluster analysis we used the export share, which is the ratio of export revenue to total revenue; the equity ratio, i.e. the ratio of equity to the balance sheet total; value added as a percentage of the balance sheet total; the short-term debt ratio, i.e. the ratio of current liabilities to the balance sheet total; after-tax profit relative to revenue; the headcount; and the ratio of the company's liquid funds to the balance sheet total. Before clustering, we standardised the examined variables. The K-means decomposition, calculated with seven variables, breaks down the 104 companies examined on the basis of 2018 data into three distinct clusters. Below we present these three groups in more detail.

Of the three clusters, the one with the smallest number of elements (22 companies) includes the FinTech companies with the highest export share (*Cluster 2*). 90 per cent of the group's members have export revenue relative to sales revenue exceeding 90 per cent. By size category, 50 per cent of the cluster are medium-sized companies. This group is characterised by high value added relative to balance sheet total. By ownership structure, the proportions for the companies are roughly equal: 13 foreign-owned and 9 Hungarian companies were included in the cluster. Although we did not utilise the database panel feature during the analysis, we can observe a general trend that the export activity of FinTech companies included in this cluster increased steadily from 2015 to 2018.

The export performance of the other two clusters is below that of the companies in the previous group. The first cluster includes high-capital – mainly micro-sized and small – companies. In line with their high equity ratio, these companies have the lowest ratio of current liabilities to the balance sheet total. Looking at the share of foreign-owned companies within the group, we can clearly see that these companies are overrepresented here. Despite the typically foreign ownership, the companies included here usually export less, and half of them have no export revenue at all. The average headcount in this cluster is the smallest, and the value added is also relatively low compared to the total sample.

The third group consists mainly of smaller, Hungarian-owned companies with lower capital adequacy. Only a small percentage of the revenue of these observations comes from export activity; 78 per cent of the companies have less than a 20 per cent export share. The group's members are characterised by a predominantly domestic ownership structure, and the value added in this cluster is the lowest compared to the total sample. The members of this cluster have the highest ratio of current liabilities to balance sheet total.

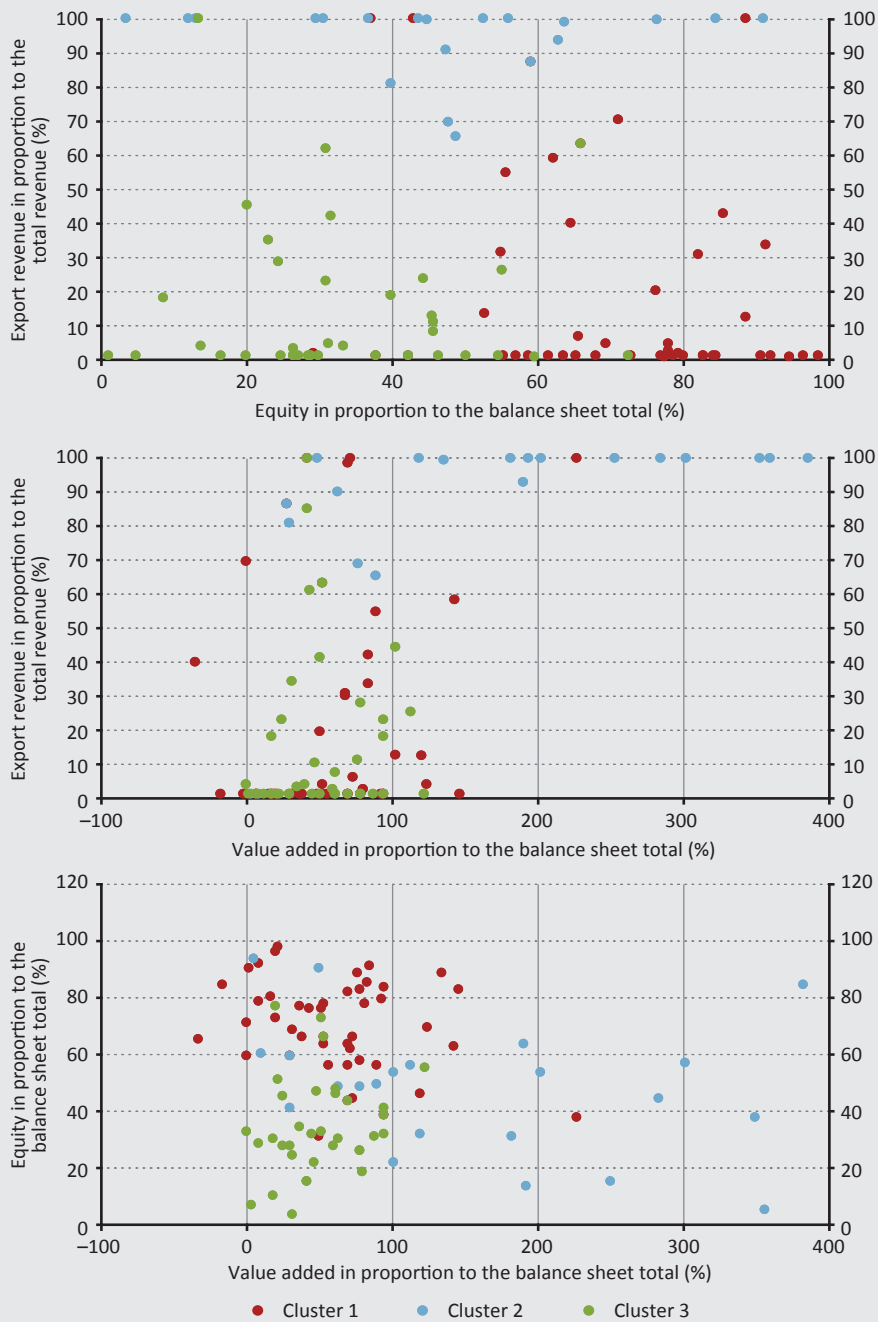
Table 3
Averages and standard errors of K-means cluster analysis

Cluster	1		2		3	
N	46		22		36	
	centroid	st. error	centroid	st. error	centroid	st. error
Export share	–0.2660	1.0319	1.3310	0.7724	–0.4736	0.8601
Equity ratio	0.8362	0.7156	–0.2548	0.8589	–0.9128	0.8400
Value added (relative to balance sheet total)	–0.3011	0.6544	1.2693	0.6836	–0.3910	1.4704
Number of employees	–0.2958	0.6851	0.9450	0.7362	–0.1996	1.7019
Current liabilities (relative to balance sheet total)	–0.7396	0.7058	0.3725	1.0779	0.7174	1.1031
After-tax profit (relative to revenue)	–0.1221	1.7146	0.1044	0.5203	0.0922	0.5867
Liquid funds (relative to balance sheet total)	–0.0027	1.1770	–0.5053	0.6329	1.2438	0.8920

Sources: National Tax and Customs Administration, MNB

Based on the examination, companies can be classified into relatively distinct groups according to the selected variables (*Figure 3*), which is well illustrated by the cluster centroids shown in *Table 3.* Companies with the same export share have been placed in the same clusters. To get a more nuanced picture, for the purpose of robustness testing, we also performed a cluster decomposition on the population of companies operating in 2017. Here, after filling data gaps and filtering outlier values, we involved 95 companies in the analysis. For this sample, too, we estimated the optimal cluster number at 3. Furthermore, the 2017 groups of companies have similar characteristics to what the clusters received in 2018 have. *Table 4* summarises the export share of each cluster by company size category in the two years examined. The export proportion in clusters 1 and 3 shows a slightly different pattern for medium-sized enterprises in the two years, yet the division indicates that for export activity we obtained similar results in terms of decomposition by company size in the case of micro-sized and small enterprises; those with typically high export revenue relative to turnover are in one group, those with a medium or lower export share are in a separate cluster, while enterprises with a particularly low export share have been included in the third group.

Figure 3
K-means clusters by export share, equity ratio and value added relative to balance sheet total, 2018



Sources: National Tax and Customs Administration, MNB

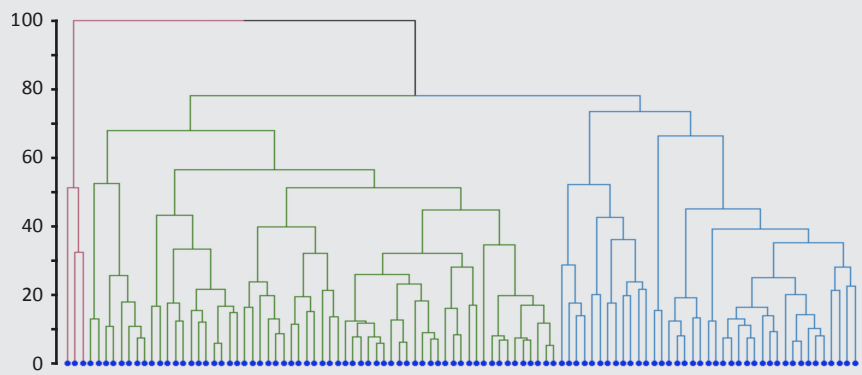
Table 4
Average (unweighted) export proportion of domestic FinTech companies by cluster, in 2017 and 2018 (%)

	2017			2018		
Cluster	1	2	3	1	2	3
N	23	26	46	46	22	36
Micro-sized	30.2	99.7	3.5	23.5	98.1	3.2
Small	27.7	90.2	5.2	19.9	100.0	14.4
Medium-sized	55.1	90.4	10.5	12.7	70.6	17.9

Sources: National Tax and Customs Administration, MNB

We also performed an agglomerative hierarchical cluster analysis of companies, whereby clusters were formed using the Ward method, considered the hierarchical equivalent of the K-means centroid method. As a starting point for the hierarchical method, each company is placed in an independent cluster, and then the groups close to each other are merged until a large cluster is formed. Apart from the first and last steps of the algorithm, intermediate group mergings bear meaning in the development of homogeneous groups. During the analysis, here too the input variables were brought to a common scale by standardisation, and then the squared Euclidean distance of the observations was measured. In the case of the Ward method, the groups are merged in such a way that the squared error resulting from the merging is the smallest (*Hair et al. 2009*). Taking into account the comparability aspect, we chose the three-cluster structure. Hierarchical (cluster-subcluster) relationships are represented by a dendrogramme (*Figure 4*).

Figure 4
Dendrogramme of hierarchical cluster analysis



Note: The different colours represent clusters.
Sources: National Tax and Customs Administration, MNB

For the hierarchical clustering procedure, in addition to the continuous variables used in the K-means algorithm, we also used the categorical variable of company age. The age variable available to us can take on four values depending on whether the company has been operating for at least 1, 2, 3, or rather 4 or more years. The age category has proved to be an important variable, but 75 per cent of the companies started operating before 2015, i.e. at least 4 years ago, and thus knowing the actual age of the companies would provide an opportunity for deeper examinations. The results of both clustering practices have categorised companies with a relatively high export ratio into one group, which confirms our assumption that among the analytical aspects of FinTech companies, the issue of delivering services to foreign markets is decisive. In the case of hierarchical clusters, companies operating for at least 2 years, producing mainly for the export market, with exceptionally high value added relative to the balance sheet total and belonging more to the middle-sized category were placed in the group with the highest population (see *Annex*). Outside the large group of 60 per cent of companies, other companies are significantly more dispersed along the variables. 39 companies ended up in the cluster, which shows a significant standard deviation both in terms of company age and the number of employees. At the same time, this group has the highest equity relative to balance sheet total. Within this group, the average export proportion is 25 per cent. Companies in the smallest cluster account for only 3 per cent of the data. The common feature of the companies here is that they produce for the domestic market, have been operating for 1–2 years and lag behind the two larger groups both in terms of value added and their equity-based indicators. As the observations were less distinct during the hierarchical cluster decomposition – almost two thirds of the companies form one cluster –, based on the comparison, we see the K-means methodology as better for the cluster analysis of domestic FinTech companies.

7. Examination of export activity based on logistic regression estimation

In order to examine export activity, we estimated a logistic regression on the 2018 cross-sectional data, which will be discussed in detail below. We performed our estimates on the company-level database of FinTech companies described above. Due to the relatively low number of observations, our model lags behind the maximally fitting models in explanatory power, but it is suitable for research purposes – such as determining the factors affecting the export activities of domestic FinTech companies and identifying their relative weight –, i.e. for exploratory modelling. To create the dichotomous outcome variable required for the logit model, we converted the continuous variable of export share discussed above into a binary variable. Since one of the important objectives of our analysis is to identify the factors affecting export activity among domestic FinTech enterprises, it is

primarily necessary to separate companies not exporting at all or only to a negligible extent from FinTech enterprises already exporting to some extent. Accordingly, in our logit model, companies with an export share of more than 10 per cent, which is not considered negligible, have been categorised as exporters; they represent value 1. To separate the effect of the characteristics of the examined companies on the target variable, the following variables were included in the estimation equation: ownership structure (foreign or domestic ownership), the previous year's value added relative to balance sheet total, headcount, long-term liabilities, company age and the square of the age variable. To eliminate endogeneity problems, the 2017 figure of value added relative to balance sheet total was included in the explanatory variables.

The model specification for logistic estimation is as follows:

$$P(exporter = 1 \mid X) = \Lambda(constant + \beta_1 ownership\ structure + \beta_2 L.value\ added + \beta_3 number\ of\ employees + \beta_4 ratio\ of\ long\text{-}term\ liabilities + \beta_5 age + \beta_6 age^2)$$

where:

$$\Lambda(z) = \frac{1}{1 + e^{-z}}.$$

The results of our estimation are summarised in *Table 5.* In general, the signs of the variables involved are in line with the hypotheses discussed above, i.e. higher value added relative to balance sheet total and long-term liabilities increase the probability of becoming an exporter. Looking at the ownership structure, we can see that, at a 5 per cent significance level, there is a positive relationship between foreign ownership and the probability of falling into the exporting category (this identified effect is also indicated by the result of the Mann–Whitney U test examining the relationship between ownership structure and export activity [*Hair et al. 2009; Kovács 2014*]; see *Annex*). For company age and age square, we have not found sufficient statistical evidence that the coefficient of the variables significantly differs from zero. Based on our tests, the estimated coefficient of the value added differs from zero at all standard significance levels. The parameter of company headcount can be considered significant at the 5 per cent level, which also positively links the higher number of employees with the probability of becoming an exporter.

Table 5
Results of the logit model for falling into the exporter category

Explanatory variables	P (Exporting = 1)
Foreign ownership	1.133*
	[0.580]
Value added (relative to balance sheet total, 2017)	0.0127***
	[0.00480]
Long-term liabilities	1.24e–05*
	[6.80e–06]
Number of employees	0.0156*
	[0.00815]
Age	6.83
	[6.304]
Age square	–1.027
	[1.033]
Constant	8.914
	[8.678]
Number of observations	100
Pseudo R-squared	**0.2323**

*Note: Standard errors are shown in square brackets; significance levels: *** p<0.01; ** p<0.05; * p<0.1.*

For logistic regression, the direct effect of parameters on probabilities cannot be interpreted, only the partial effect. *Table 6* shows the marginal effects calculated at the average.[4] The variable of ownership structure category takes a value of 0 if the company is domestic and a value of 1 if the company is foreign-owned. In the case of the marginal effect taken at the average, it shows how much the probability of falling into the exporting category changes if the examined company is foreign (compared to a domestic company), while at the same time, the other variables assume their values taken at the average. The average marginal effect of foreign ownership is 0.2727, which means that for two hypothetical companies with average and equal financial indicators and headcount figures relative to the balance sheet total, the probability of exporting is 0.27 higher for the foreign company than for its domestic counterpart.

Table 6
Marginal effects calculated at averages based on the logit model

	Average marginal effect	Standard error	P>|z|	Average
Ownership structure	0.2727	0.1283	0.034	0.27
Value added (rel. to balance sh. tot.)	0.0032	0.0012	0.008	62.06
Headcount	0.0039	0.0020	0.056	29.65

[4] For binary variables, the marginal effect measures how predicted probabilities change as a result of a discrete change in our binary variable, i.e. where it takes a value of 1 instead of 0. In the case of continuous variables, the marginal effects provide a good approximation of the change measured in the outcome variable as a result of a one-unit increase in the explanatory variable.

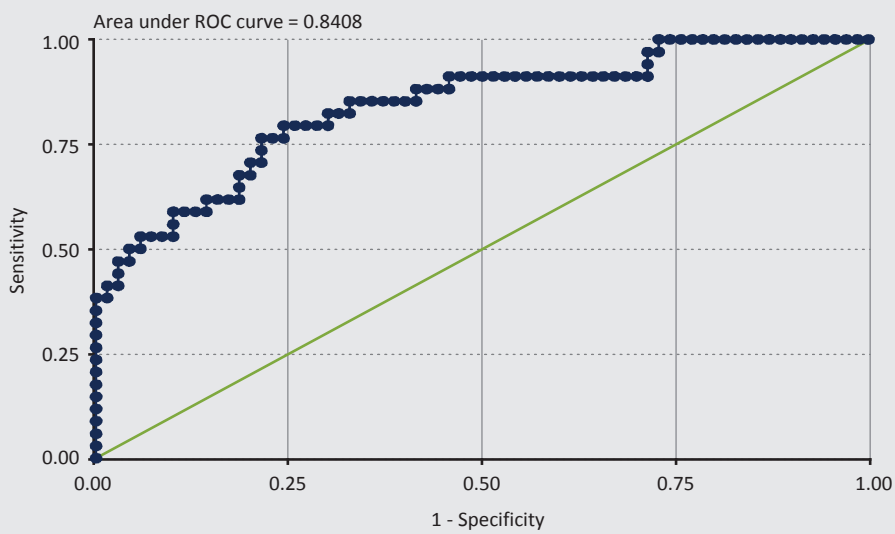
Based on the confusion matrix calculated from the results of the logistic regression, our model correctly estimates the export activity (exporter or non-exporter) of the companies in the sample at around 77.2 per cent. The elements of the confusion matrix can be interpreted at a given cut-off value, by changing which the elements of the matrix also take on a new value (*Table 7*). During classification, above a probability limit of 0.5 the prediction of a given observation to fall into the exporter category was considered to be an estimated exporter.

Table 7
Confusion matrix

Estimate-based predicted value of export activity	Export activity based on observations	
	Non-exporter	Exporter
Non-exporter	87%	33%
Exporter	13%	67%

Figure 5 shows the ROC curve, i.e. the rate of correctly predicted exporting companies relative to that of those classified erroneously as exporting companies, as a function of different cut-off values.

Figure 5
ROC curve



8. Conclusions

In our analysis, we examined domestic FinTech SMEs by using micro-data, focusing on the export activity of companies in the domestic FinTech sector. Our study offers new content not only because of the range of examined enterprises, but also due to the uniqueness of the database used, as we endeavoured to give a deeper picture of domestic FinTech companies with the help of company data rarely used thus far. Our examination had a twofold purpose: First, we identified and briefly described the distinct groups of domestic FinTech companies based on different company characteristics (headcount, export activity, financial data), and second, by using logistic regression estimation on the cross-sectional data, we identified the most important factors affecting the export activity of domestic FinTech companies.

In our study, we presented how the domestic FinTech companies examined were identified, and we briefly reviewed the range of data used. Next, we examined whether a relationship between the service range and the ownership background of domestic FinTech companies in our sample could be identified, and then, we performed a cluster analysis of domestic FinTech SMEs, with special regard to the export activity of the companies examined. Our results have shown that small and medium-sized FinTech companies active in Hungary can be divided into three distinct groups based on the company characteristics involved: export share, headcount and various financial indicators. Of the three clusters, the cluster with the smallest number of elements, 22 companies, has the FinTech companies with the highest export share. 90 per cent of the group's members have export revenue relative to sales revenue exceeding 90 per cent. By size category, 50 per cent of the cluster is made up of medium-sized companies, and the group is characterised by high value added relative to balance sheet total. Interestingly, despite the strong export activity, FinTech enterprises with a foreign ownership background are not substantially overrepresented in this cluster: the proportion of companies is roughly balanced based on ownership structure.

By estimating logistic probability models, we sought to answer the question of how certain characteristics of companies (foreign ownership, value added, headcount, etc.) had had an impact on becoming an exporting company. Looking at the ownership structure, we identified a significant positive relationship between the probability of falling into the exporter category and foreign ownership. Parameters of the value added to balance sheet total ratio and of the headcount variable also indicate a positive relationship.

The results of this analysis are also worth examining from an economic policy perspective. First, it is important to know that the domestic FinTech sector, although relatively small, can still be considered fundamentally competitive, as even in a relatively narrow, globally highly competitive segment such as the FinTech

sector, Hungarian companies with strong export activity and high value added can be substantially identified. Second, it can be concluded from our analysis that higher value added increases the probability of FinTech companies' export activity, and thus a more active presence in the export market is expected if this factor is strengthened. This can be relevant for both domestic stimulus policy and domestic export strategy.

References

Anagnostopoulos, I. (2018): *Fintech and regtech: Impact on regulators and banks*. Journal of Economics and Business, 100(November-December): 7–25. https://doi.org/10.1016/j.jeconbus.2018.07.003

Arner, D.W. – Barberis, J.N. – Buckley, R.P. (2015): *The Evolution of Fintech: A New Post-Crisis Paradigm?* University of Hong Kong Faculty of Law Research Paper No. 2015/047. http://dx.doi.org/10.2139/ssrn.2676553

Bhandari, M. (2016): *India and the Pyramid of Opportunity*. In: Chishti, S. – Barberis, J: The FinTech Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, pp. 81–83. https://doi.org/10.1002/9781119218906.ch22

Bijmolt, T.H.A. – Zwart, P.S. (1994): *The impact of internal factors on the export success of Dutch small and medium-sized firms*. Journal of Small Business Management, 32(2): 69–83.

Buchak, G. – Matvos, G. – Piskorski, T. – Seru, A. (2018): *Fintech, regulatory arbitrage, and the rise of shadow banks*. Journal of Financial Economics, 130(3): 453–483. https://doi.org/10.1016/j.jfineco.2018.03.011

Dietz, M. – Olanrewaju, T. – Khanna, S. – Rajgopal, K. (2015): *Cutting through the noise around financial technology*. https://www.mckinsey.com/industries/financial-services/our-insights/cutting-through-the-noise-around-financial-technology#

Douglas, J.L. (2016): N*ew Wine Into Old Bottles: Fintech Meets the Bank Regulatory World*. Banking Institute Journal, 20(1): 17–65.

Eickhoff, M. – Muntermann, J. – Weinrich, T. (2017): *What do FinTechs actually do? A taxonomy of FinTech business models*. Conference Paper, International Conference on Information Systems 2017, South Korea.

Fáykiss, P. – Papp, D. – Sajtos, P. – Tőrös, Á. (2018): *Regulatory Tools to Encourage FinTech Innovations: The Innovation Hub and Regulatory Sandbox in International Practice*. Financial and Economic Review, 17(2): 43–67. http://doi.org/10.25201/FER.17.2.4367

FSB (2017): *Financial Stability Implications from FinTech*. Financial Stability Board. https://www.fsb.org/2017/06/financial-stability-implications-from-fintech/

Gai, K. – Qiu, M. – Sun, X. (2018): *A survey on FinTech*. Journal of Network and Computer Applications, 103(February): 262–273. https://doi.org/10.1016/j.jnca.2017.10.011

Gazel, M. – Schwienbacher, A. (2020): *Entrepreneurial fintech clusters*. Small Business Economics. https://doi.org/10.1007/s11187-020-00331-1

Gimpel, H. – Rau, D. – Röglinger, M. (2018): *Understanding FinTech start-ups–a taxonomy of consumer-oriented service offerings*. Electronic Markets, 28(3): 245–264. https://doi.org/10.1007/s12525-017-0275-0

Goldstein, I. – Jiang, W. – Karolyi, G. A. (2019): *To FinTech and beyond*. The Review of Financial Studies, 32(5): 1647–1661. https://doi.org/10.1093/rfs/hhz025

Hair, J.F. – Black, W.C. – Babin, B.J. – Anderson, R.E. (2009): *Multivariate Data Analysis*. 7th Edition. Pearson.

Jutla, S. – Sundararajan, N. (2016): *India's FinTech Ecosystem*. In: Chishti, S. – Barberis, J: The FinTech Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, pp. 56–57. https://doi.org/10.1002/9781119218906.ch15

Kim, Y. – Park, Y.J. – Choi, J. (2016): *The Adoption of Mobile Payment Services for "Fintech"*. International Journal of Applied Engineering Research, 11(2): 1058–1061.

King, B. (2014): *Breaking Banks: The Innovators, Rogues, and Strategists Rebooting Banking*. New York: John Wiley & Sons.

Kovács, E. (2014): *Többváltozós adatelemzés* (*Multivariate data analysis*). Typotex.

Lee, I. – Shin, Y.J. (2018): *Fintech: Ecosystem, business models, investment decisions, and challenges*, Business Horizons, 61(1: 35–46. https://doi.org/10.1016/j.bushor.2017.09.003

Melitz, M.J. (2003): *The impact of trade on intra-industry reallocations and aggregate industry productivity*. Econometrica, 71(6): 1695–1725. https://doi.org/10.1111/1468-0262.00467

Miesenblock, K.J. (1988): *Small business and exporting: a literature review*. International Small Business Journal, 6(2): 42–61. https://doi.org/10.1177/026624268800600204

MNB (2019): *Competitiveness Programme in 330 points*. Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/competitiveness-programme-in-330-points.pdf

MNB (2020): *FinTech and Digitalisation Report*. Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/fintech-es-digitalizacios-jelente-s-final-eng.pdf

Müller, J. – Kerényi, Á. (2019): *The Need for Trust and Ethics in the Digital Age – Sunshine and Shadows in the FinTech World*. Financial and Economic Review, 18(4): 5–34. http://doi.org/10.33893/FER.18.4.534

Varga, D. (2017): *FinTech, the new era of financial services*. Budapest Management Review, 48(11): 22–32. https://doi.org/10.14267/VEZTUD.2017.11.03

Annex

Table 8
Examination of relationship between ownership background and service range for domestic FinTech SMEs by Phi and Cramer V tests

	Value	Approx. sig.	Exact sig.
Phi	0.203	0.639	0.611
Cramer V	0.203	0.639	0.611
N	104		

Table 9
Normality test for export activity and ownership background

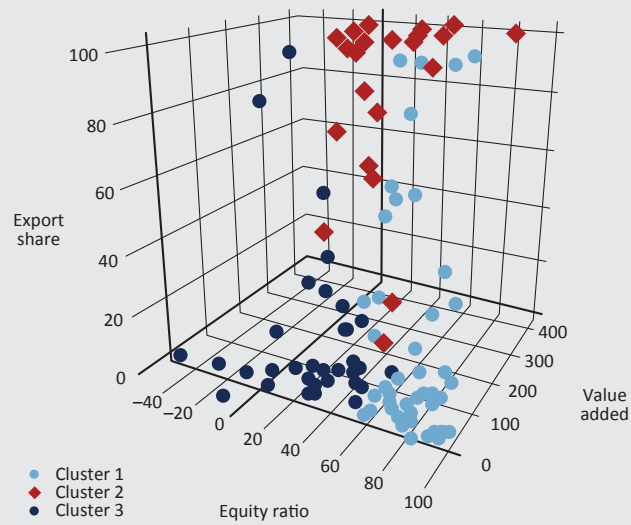
		Kolmogorov–Smirnov[a]			Shapiro–Wilk		
Export share		**Stat.**	**df**	**Sig.**	**Stat.**	**df**	**Sig.**
Ownership background	Domestic	0.300	76	0.000	0.673	76	0.000
	Foreign	0.239	29	0.000	0.774	29	0.000

Note: a) Lilliefors Significance Correction.

Table 10
Examination of relationship between export activity and ownership background of domestic FinTech SMEs by Mann–Whitney U independent-sample test

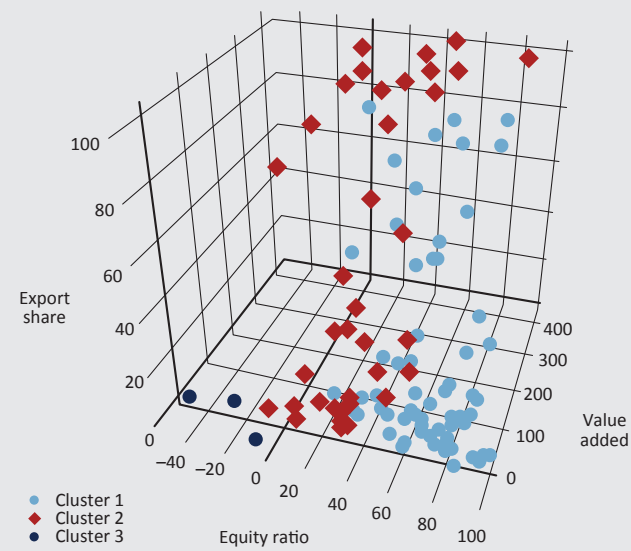
Total N	104
Mann–Whitney U	1,583.500
Wilcoxon W	1,989.500
Test statistic	1,583.500
Standard error	131.750
Standardised test statistic	3.943
Asymptotic sig. (2-sided test)	0.000

Figure 6
K-means clusters by export share, equity ratio and value added relative to balance sheet total, 2018



Sources: National Tax and Customs Administration, MNB

Figure 7
Hierarchical clusters by export share, equity ratio and value added relative to balance sheet total, 2018



Sources: National Tax and Customs Administration, MNB

Last Resort: European Central Bank's Permanent Engagement in Tackling Foreign Exchange Liquidity Disruptions in the Euro Area Banking System*

Gábor Dávid Kiss – Gábor Zoltán Tanács – Edit Lippai-Makra – Tamás Rácz

Prior to the outbreak of the global financial crisis, the international interbank market for key currencies narrowed and market participants faced foreign currency liquidity shocks more frequently. The US Federal Reserve was first to address the problem with a series of currency swap lines concluded with other major central banks after December 2007. Although these measures were initially considered temporary, they are still present today in the practices of the leading central banks, and thus of the European Central Bank. Inter central bank currency swap lines facilitate, if necessary, the provision of an adequate level of foreign currency liquidity to the banking system as a kind of "last resort", on more favourable terms than market conditions. In our study, we examined the evolution of the demand for foreign currency liquidity provided by the European Central Bank to the euro area banking system between 2007 and 2019, on quarterly data and using vector autoregression. We found that the allocation of dollar-denominated foreign currency resources through the ECB's tenders increases the most when the banking system is unable to raise international funds on a market basis, when dollar market tensions rise or when their return on assets ratios deteriorate.

Journal of Economic Literature (JEL) codes: E52, E58, E44, C22

Key words: last resort, foreign exchange liquidity, foreign exchange swap, repo, tender, banking system, unconventional monetary policy, ECB, VAR

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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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The research was supported by the project EFOP-3.6.2-16-2017-00007, Aspects of the Development of a Smart, Sustainable and Inclusive Society: Social, Technological, Innovation Networks in Employment and the Digital Economy. The project is supported by the European Union, co-financed by the European Social Fund and the Hungarian budget.

The Hungarian manuscript was received on 23 April 2020.

DOI: http://doi.org/10.33893/FER.19.4.83106

1. Introduction

Fundraising and lending denominated in foreign currency has become significant in the banking systems of developed countries since the 1960s. First US dollar deposits appeared under the liabilities of Western European credit institutions, followed by petrodollars from oil-exporting countries (*Madura 2008*). At the same time, we can now talk about institutional investors in this field who have appeared with tax optimisation intentions, and we can also refer to deposit placements from capital flight (*Kiss – Ampah 2018*). We can see that both international trade and the institutional weaknesses of developing countries are creating excess foreign exchange liquidity in developed markets, which is then allocated: today, the dollar accounts for approximately 60 per cent of foreign exchange reserves, the international bond market and private lending, the euro 20 per cent, while the share of yen and renminbi is below 5 per cent (*ECB 2019*). However, disruptions in the network structure of the international interbank market[1] can lead to a serious lack of liquidity.

During the global financial crisis of 2007–2008, the flow of international liquid capital suddenly narrowed or even stopped suddenly in some channels, which made financing on market terms difficult even if the public debt or banking system of the given country had not had any problems before. While the resources of the International Monetary Fund (IMF) are typically used to address national near-bankruptcy situations, and during the European sovereign debt crisis the bank bailout largely relied on lending via the European Stability Mechanism (ESM) and its predecessors, the conditions of providing short-term foreign currency liquidity was less institutionalised. These foreign currency liquidity needs typically stem from the turmoil on international financial markets, thus they can emerge quickly and vary widely in magnitude. In our study, we will explain the background to this ad hoc foreign currency liquidity provision through the example of the European Central Bank (ECB), making special reference to currency swap lines established by major central banks and regionally. A currency swap can be used extensively, *inter alia*, for liquidity management, risk hedging and short-term yield speculation (*Mák – Páles 2009*), but in the course of our work we analyse these transactions solely on the basis of the central banks' international function to acquire foreign currency liquidity. To assess changes in foreign exchange exposure, it is also worth separating currency swaps (where the foreign exchange exposure changes) from repurchase transactions (where the exposure does not change) conducted with foreign currency-denominated securities collateral – however, liquid assets are required in both cases.

[1] See, for example: The results of *Ananda et al.* (*2012*); *Allen – Babus* (*2009*) on the topology changes of US interbank markets, or *Berlinger et al.* (*2011*); *Banai et al.* (*2015*) on that of the Hungarian.

Although it seemed at first that the European banking system would only turn to the ECB for foreign exchange liquidity on a temporary basis, practice shows that this instrument has had to be used for almost 13 years, and the COVID-19 crisis in 2020 has further increased the amount of capital allocated. In the course of our work therefore, we examine the change in the capital allocated by the ECB in US dollar-denominated tenders with euro area credit institutions between 2007 and 2019, using a vector autoregression model. To this end, we analysed the ratio of the non-euro-area non-euro denominated liabilities of the banking system to the balance sheet total, the dollar market tensions indicated by the EUR-USD basis swap, the banking system's return on assets and the structural changes on the asset side of the ECB's balance sheet. To establish the foundations of the theoretical model, we first present the evolution of currency swap lines between central banks during the period under review, as well as the relevant practice of the ECB. Next, we describe the data and methodology used, and finally, we evaluate the obtained results in light of the intuitions formulated for the theoretical model. We found that, although financing costs did not, the other variables had a significant impact even in the medium term on euro area credit institutions turning to the ECB when they needed foreign exchange liquidity.

2. Theoretical background

Prior to the global financial crisis, between 2003 and 2007 the aggregate loan-to-deposit ratio of euro area banks was above 100 per cent, and financed increasingly from money market funds in addition to significant bond holdings (*ECB 2008*). This chapter summarises the central bank swap lines and the changes to the euro area banking system that have led to an appreciation of the ECB's role in providing stable foreign currency liquidity to the banking system as a direct consequence of the above situation. The fact this role has remained and has accompanied the functioning of the ECB to this day is also reflected in the theoretical model developed in this study.

2.1. Swap lines between central banks

In the toolbox of unconventional monetary policy that spread following the 2007-2008 global financial crisis, in addition to the bond market's function of "market maker of last resort", the instrument of foreign currency funding was added to the traditional "lender of last resort"[2] function of central banks (typically for short maturities, O/N and 3-month) (*BIS 2011; Seghezza 2018; Ács 2011*). This is because a central bank may also decide not to invest an existing foreign currency resource in a foreign asset, but to continue lending to national credit institutions, which

[2] Although the term "lender of last resort" is used in international literature, due to the mass application of repo transactions, this means funding in a broader sense.

would, however, result in a decrease in foreign exchange reserves. Since foreign exchange reserves must meet the expectations set by credit rating agencies and other stakeholders (e.g., Guidotti-Greenspan and M2 rules), it seemed appropriate to expand the range of foreign exchange sources (*Obstfeld et al. 2009*). This can be realised by issuing bonds in foreign currency (which in turn are considered government securities), collecting deposits in foreign currency, or borrowing (from another central bank or the Bank for International Settlements), but this is more difficult to achieve in a market with a lack of liquidity. In this case, it is possible to borrow within an institutionalised framework (IMF or Regional Financing Agreements) or to resort to alternative, ad-hoc foreign exchange resources (interbank swap and repo lines) (*Antal – Gereben 2011*).

In a currency swap between central banks, the two central banks lend to the other party in their own currency, thus taking both spot and forward positions[3], where the exchange rate difference between the two positions is the swap point. A swap line can provide access to foreign currency liquidity in a decentralised manner, which seems faster and more flexible compared to the terms of an institutionalised (e.g. IMF) loan[4]. As a result, however, currency swap lines can have a number of pitfalls: their creation requires a counterparty central bank with opposing foreign exchange demand; at the end of the line, the counterparty may decide to terminate the continuation; central banks issuing key currencies are free to choose between potential counterparties and there is a lack of collateral against default[5] (*Destais 2016*).

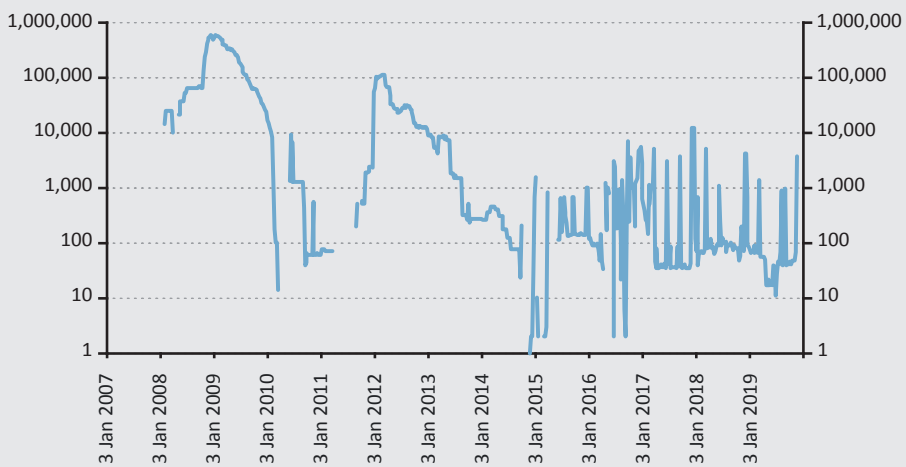
Inter-central bank ad-hoc currency swap lines have appeared on international markets since the 1920s, typically with a maturity of 3 months, which the US Federal Reserve (Fed) raised to a higher level from 1962 by establishing the network of swap lines, also including Western central banks and the BIS, to address imbalances arising from the Triffin paradox[6] (*Bordo et al. 2015*). At the focus of this was the dollar as the gold-backed world money of that time. From the post-Bretton Woods era we can mention the 2001 dollar swap line, where now the ECB appeared as the issuer of the newly created euro.

The transitional (6-month) inter-central bank dollar swap line, initially with four leading central banks (Canadian, British, Swiss and the ECB), established in

[3] The market can deviate significantly from the level justified by the covered interest rate parity due to stress, as stated by *Csávás – Szabó* (*2010*). *Brophy et al.* (*2019*) added to this the additional biases resulting from central bank bond purchase programs.
[4] In particular due to its budgetary and economic policy implications, which are completely missing from a swap line.
[5] Although in this case it is also possible to conclude a repo agreement.
[6] The dollar was a national currency and a key global currency at the same time, so while the latter requires the US balance of payments to be in a deficit to satisfy international dollar requirements (resulting in an outflow of gold reserves in the long run), the short-term domestic economic policy objectives might run counter to this.

December 2007, elevated the Fed to the position of international lender of last resort. The other central banks of the G10 countries joined this in March 2008, and subsequently the Central Bank of Japan in September 2008. The agreements were regularly renewed every six months, while on 1 February 2010, the international financial markets apparently no longer required this type of channel, therefore the central banks considered the cooperation closed[7]. However, this kind of optimism did not prove lasting, as this type of transitional dollar swap line had to be re-established in May 2010[8] (*Figure 1*). Following a series of renewals to the cooperation, the counterparties reached a point in December 2011 where they were able to swap not only in dollars but also in their own currencies[9] (i.e. in Canadian dollars, pounds, yen, Swiss francs and euros, in addition to the US dollar). By the end of October 2013, it became clear to the parties that the "transitional" swap lines, which had been ongoing for almost six years, could not yet be cancelled for a long time, despite the temporary easing of foreign exchange liquidity needs, thus the six founding central banks entered into a standing arrangement[10].

Figure 1
Value of swap lines entered into by the Fed with central banks (weekly average, million dollars, plotted on a logarithmic scale)



Source: Plotted based on the Fed's database

[7] https://www.ecb.europa.eu/press/pr/date/2007/html/pr071212.en.html
[8] https://www.snb.ch/en/mmr/reference/pre_20100510_3/source/pre_20100510_3.en.pdf
[9] https://www.ecb.europa.eu/press/pr/date/2011/html/pr111130.en.html
[10] http://www.ecb.europa.eu/press/pr/date/2013/html/pr131031.en.html

Under the agreements, the liquidity thus acquired was lent by central banks through various channels: the ECB typically conducted repo tenders with O/N, 1-week, 1-month and 3-month maturities. The severity of the market problem is well illustrated by the fact that the ECB still carries out lending in US dollars to this day, meaning that between December 2007 and March 2020, the purely market-based international financing did not fully recover in reserve currencies either! Thus, the "last resort" function has now verifiably been added to the tasks of the leading central banks, also in ensuring the adequate foreign currency liquidity of the banking system.

In the case of a central bank issuing a reserve currency, it is expected that it will easily be able to find a counterparty for a currency swap as it provides loans to the other party in a foreign currency that can be lent domestically. And if the liquidity needs of the banking sector would not absorb this type of liquidity, it can still replenish its international reserves. The individual regional interbank swap lines add further nuances to the situation: in October 2008, the Fed entered into similar agreements with the central banks of Brazil, Mexico, South Korea and Singapore (*Seghezza 2018*). Similarly, the Scandinavian (Danish, Norwegian and Swedish) central banks were able to obtain dollar liquidity. This is interesting because the very same central banks concluded euro swap lines with the ECB too in autumn 2008, while from May 2008 they entered into euro swap lines with the central bank of Iceland, then of Latvia in December 2008, and finally from May 2009 with the Estonian central bank. Subsequently, this kind of solidarity was embodied in the conclusion of a cooperation agreement[11] in August 2010, which institutionalised cross-border financial stability, crisis management and bank consolidation. The rationale behind the *Nordic Baltic Stability Group* was the Baltic dominance of Swedish banks, and its success is clearly shown by the accession of the Baltic countries to the euro area and the renewal of cooperation in 2018[12].

The ECB also entered into euro-pound and euro-Swiss franc swap lines between 2008 and 2010. However, with respect to non-euro area Member States (e.g. Poland, Hungary and Latvia), it mainly gave priority to covered repurchase agreements (by accepting euro-denominated bonds) (*Allen – Moessner 2010*). By contrast, the Swiss and Polish central banks entered into a Swiss franc-zloty swap line in 2012. We can state that in the case of small, emerging, open economies, it was still best to address capital flow disruptions through the institutional instrument of conditional lending, the IMF loan – even if Poland did not use the flexible credit line made available to it between 2009 and 2017. According to the results of *Obstfeld et al.* (*2009*), the inadequacy of foreign exchange reserves relative to M2 in emerging

[11] https://www.cb.is/publications/news/news/2010/08/17/Nordic-and-Baltic-Ministries--Central-Banks-and-Supervisory-Authorities-sign-Agreement-on-Financial-Stability-/
[12] https://www.fi.se/en/published/news/2018/new-nordic-baltic-memorandum-of-understanding/

countries well explains the devaluation of currencies, and the fact that the swap lines implemented can be considered rather symbolic in terms of their magnitude is also attributable to this.

Contrary to the above, the motivation for the renminbi swap lines entered into by the Chinese central bank after 2008 was not a central bank response to the shock manifested in the availability of an already fully used reserve currency, but rather another attempt to resolve the Triffin dilemma (*Seghezza 2018*). Namely, based on this, the renminbi liquidity received during the agreement should appear among the liabilities then among the assets of the banking system, thus gaining an increasing role in the line of international means of payment (*Engelberth – Ságі 2017*).

Global dollar funding depends on the operation of both US and non-US (typically Japanese, UK, Canadian, French, German and Dutch) banks. In the case of Japanese banks, while *Aldasoro et al.* (*2019*) observed a significant increase, a near doubling, of dollar-denominated assets between 2007 and 2017 as traditional commercial banking activity improved, in the case of European banks the asset and liability sides more than halved during this time and short-term arbitrage transactions began to gain priority. Dollar funding for non-US global banks comes primarily through US money market funds, which used repo-type channels to a lesser extent and non-repo type[13] channels to a greater extent in an increasingly concentrated market during the 2010s. For these funds, the Fed's overnight reverse repo instrument represents the safest investment alternative in addition to short-term government bonds, thus a position with non-US banks should provide a premium above this.

2.2. ECB's foreign currency lending

In the autumn of 2007, the European banking system not only had significant leverage on its US counterpart, but also had significant US exposures on the asset side (*Pelle – Végh 2019*). Companies with international foreign currency income, other actors with domestic foreign currency income on the asset side of the bank balance sheet, as well as the ratio of foreign currency resources all determine the extent of any currency mismatch in the case of a credit institution (*Destais 2016*; *Mák – Páles 2009*). The liabilities side includes foreign currency deposits of domestic or foreign institutional investors, as well as short-term bonds issued in foreign currency or repo transactions, which require frequent renewal due to the maturity transformation.

[13] Short-term securities, such as: commercial paper, certificates of deposit, asset backed commercial papers.

The renewal of foreign currency liquidity can be particularly problematic when the weight of foreign currency resources is relatively high within the balance sheet ($\frac{L_{nEZ,t}}{TL_t} > 0$). *Páles et al.* (*2010*), for example, derives the change in the derivative position with non-residents from the net borrowing requirement as the difference between non-debt-generating capital inflows, forint and foreign currency debt, the actual open position of the banking system and the derivative position with the domestic private sector. Although the use of foreign currency resources is typically mentioned in literature when describing the inconsistency of foreign currency devaluations in developing countries (see *Frankel 2011* for example), as mentioned in the previous subsection, a currency mismatch can cause a problem in developed markets too.

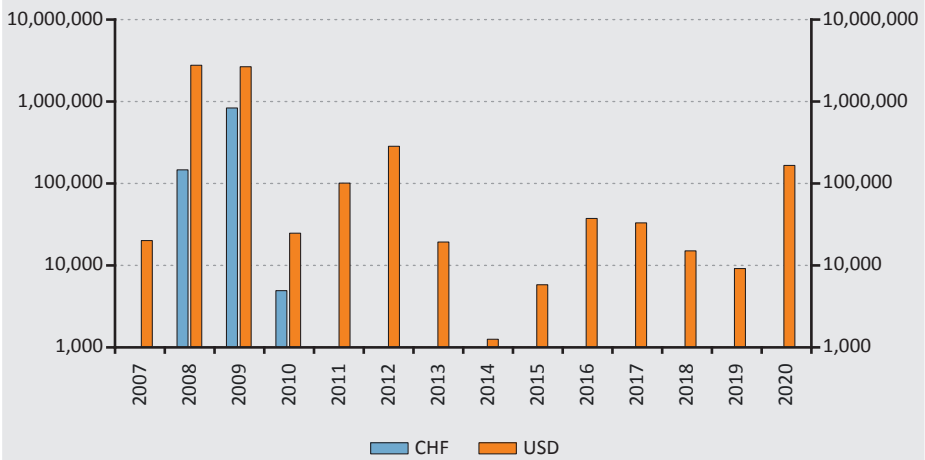
According to[14] *Destais* (*2016*), since the collateral behind an inter-central bank swap line is created by the quality of credit institution use and the ability to repay, this credibility is ultimately a macroprudential issue (*Baker 2013*). The rate of return on assets (ROA_t) can thus have a direct effect on the desirability of a bank in the international interbank market if it wants to acquire foreign currency liquidity. In the case of rational market participants, a deteriorating *ROA* could push the market towards central bank foreign currency auctions. This kind of "aversion" may also stem from tensions in the international dollar market, which can be captured most effectively by the change in the basis swap between the two key currencies, the dollar and the euro ($bS_{3M,\frac{EUR}{USD}}$), after *Kick et al.* (*2018*) demonstrated the effective pass-through of the US financing environment into the euro area. In the course of their work, the effects of the Fed's unconventional actions on dollar financing were felt by German banks. Based on *Figure 2*, we can conclude that the ECB has to conduct foreign currency repo tenders primarily in US dollars, while the appearance of the Swiss franc has proven to be episodic. From the perspective of our work, therefore, we will focus on the change in the dollar liquidity ($K_{USD,t}$) provided by the ECB in tenders.

[14] In the case of market-based swaps there is a margin requirement; the value of margin call for the total net swap portfolio maturing in foreign currency at *i* times in relation to the VOL_i contract not yet expired:

$$MC_t = \sum_{i=0}^{N_t} \frac{s_t - S_{0,i}}{S_t} \cdot VOL_i,$$

where $S_{0,i}$ is the spot exchange rate of each *i* transaction at the time of conclusion, s_t is the spot exchange rate, N_t is the number of transactions not expired at the given time (*Páles et al. 2010*).

Figure 2
Developments in US dollar and Swiss franc liquidity lent in the ECB's repo tenders between 2007 and 2020 (€ million)



Source: Plotted based on ECB's data

The issue of foreign currency liquidity provided by the ECB within the euro area is not a much-studied area in literature; the analysis of cross-border lending in a reserve currency is a much more popular topic. *Alvarez et al.* (*2017*) described the phasing out of longer maturities for the various interbank foreign currency swap lines (1-week, 1-month and 3-month) following the passing of global crises, emphasising that the ECB provides dollar liquidity to the euro area banking system mainly through repo tenders against adequate collateral. So in the latter case we cannot talk about a change in foreign currency exposure, whereas in the case of a foreign currency swap, we can. However, market demand for the latter has dropped significantly since 2009.

Takáts – Temesvary (*2020*) also focuses primarily on the monetary policy transmission effects of cross-border foreign currency lending, emphasising that monetary policy impacts on cross-border foreign currency lending even if neither the lender nor the debtor is resident. On the other hand, the interbank role of this type of lending is negligible, basically non-bank actors have emerged as debtors. Similarly to them, *Avdjiev et al.* (*2016*) examined cross-border lending in euros, incidentally finding a 30 per cent share of the dollar in the euro area in this area. In their model, in addition to variables describing lending, the exchange rate was also present in addition to banks' share prices and sovereign risk. In their work, they found that, in addition to the international dollar-denominated lending network, there is also a more modest, but euro-denominated lending network that is gaining momentum due to the ECB's unconventional monetary policy. However, by

specifically examining the lending of European banks in dollars, *Ivashina et al.* (*2015*) found that the increase in lending in euros was accompanied by a deterioration in the quality of the loans they provided. Parallel to this, they also highlight the narrowing of traditional market channels, which has made access to dollar liquidity expensive. *Albrizio et al.* (*2020*) originates the decline in cross-border dollar lending from the monetary shock resulting from the exogenous tightening of the Fed. In addition, *Aizenman et al.* (*2020*) and *Seghezza* (*2018*) thoroughly examined the relationship between the composition and relative size of international foreign currency reserves and macro variables, looking at the impact of swap lines separately, however, the authors do not analyse the specific demand set by credit institutions themselves vis-à-vis their central bank with respect to the motivation to acquire foreign currency liquidity.

2.3. Theoretical model

In summarising the literature, we found that the motivation for swap lines between central banks was that commercial banks had difficulty accessing foreign currency funding in international interbank markets. To satisfy this hunger for foreign currency liquidity, central banks provided liquidity obtained through international swap lines through tenders for their own banking system. This is the ratio of dollar liquidity provided in a given quarter to total lending measured over the entire period, denoted by $\frac{K_{USD,t}}{\sum K_{USD}}$ in our model as the result variable. The ratio of non-euro-area liabilities of euro area credit institutions to total assets ($\frac{L_{nEZ,t}}{TL_t}$) characterises the external exposure of the banking system well. As an indicator of dollar market tensions, we use the 3-month EUR-USD basis swap[15] ($bS_{3M,\frac{EUR}{USD}}$), the negative value of which indicates an increase in funding in dollars. The profitability of the credit institutions involved was included in the model using return on assets (ROA_t). The ECB's securities market (S_t) and lending (L_t) practices that are becoming active were measured by the ($\frac{L_t + S_t}{FX_t}$) ratio measuring the restructuring of the central bank's balance sheet and apportioning with the international reserve (FX_t).

The fractures in capital flows due to changes in business cycles were represented by the dummy variable of the recession ($d_{EZr,t}$) emerging in the euro area. On the other hand, to ensure the normal distribution of the error terms of the regressions, it was advisable to include a dummy variable ($d_{out,t}$) representing the fall of dollar liquidity to zero.

[15] Currency Basis Swap: 3M EURIBOR/3M USD LIBOR, ICAP

In the course of our work, we examine the above variables using the following theoretical model between 2007 Q4 and 2019 Q4 (*t=1:49*):

$$\Delta\frac{K_{USD,t}}{\sum K_{USD}} = \omega + \beta_1\Delta\frac{L_{nEZ,t}}{TL_t} + \beta_2\Delta\frac{bS_{3M,\frac{EUR}{USD},t}}{100} + \beta_3\Delta ROA_t + \beta_4\Delta\frac{L_t + S_t}{FX_t} + \beta_5 d_{EZr,t} + \beta_6 d_{out,t} \quad (1)$$

In this model, we can formulate the following intuitive expectations for each coefficient: increasing external exposure could mean that credit institutions are able to raise funds on a market basis and are therefore expected to make less use of the ECB's dollar liquidity allocation tenders, thus $\beta_1 < 0$ is expected. The declining level of the foreign currency swap reflects the banks' increasing hunger for liquidity, which encourages the ECB to increase its dollar liquidity lending ($\beta_2 < 0$). If the ROA falls, it is expected that banks will rely much more on a form of financing that is more favourable than the market, thus we expect a ($\beta_3 < 0$) negative coefficient here. The increasingly serious credit and securities market interventions by the central bank indicates the liquidity allocation in foreign currency ($\beta_4 > 0$). The appearance of these expectations can also be expected at the level of impulse response functions and variance decompositions. The theoretical model was tested using Eviews 11 software.

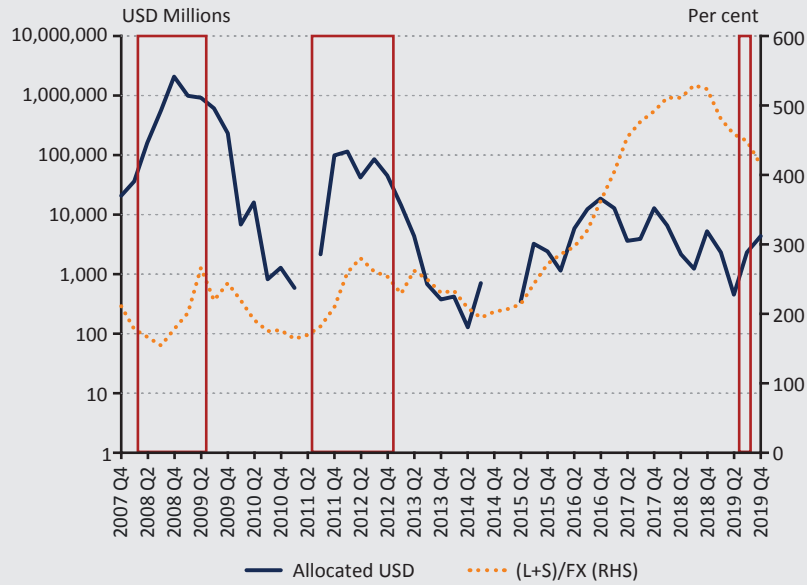
3. Data and methodology

3.1. Data

The dollar-denominated swap lines of leading central banks have gained major traction since December 2007, thus the sample under review covers 49 quarters between the last quarters of 2007 and 2019. The sources of the data used were as follows: information on lending in foreign currency tenders was downloaded from the ECB's database listing open market operations denominated in foreign currency[16], and then data on individual tenders were aggregated to a quarterly basis as described in the theoretical model subsection. Balance sheet and ROA data for euro area credit institutions were downloaded from the relevant statistical database of the ECB[17]. The foreign currency basis swap time series was downloaded from the Refinitiv Eikon database. The dummy variable, which symbolises the recession quarters of the euro area, was created based on a database of the European Commission[18].

[16] https://www.ecb.europa.eu/mopo/implement/omo/html/top_history.en.html
[17] http://sdw.ecb.europa.eu/browse.do?node=9691316
[18] https://ec.europa.eu/eurostat/cache/bcc/bcc.html

Figure 3
Values of monetary policy variables included in the model

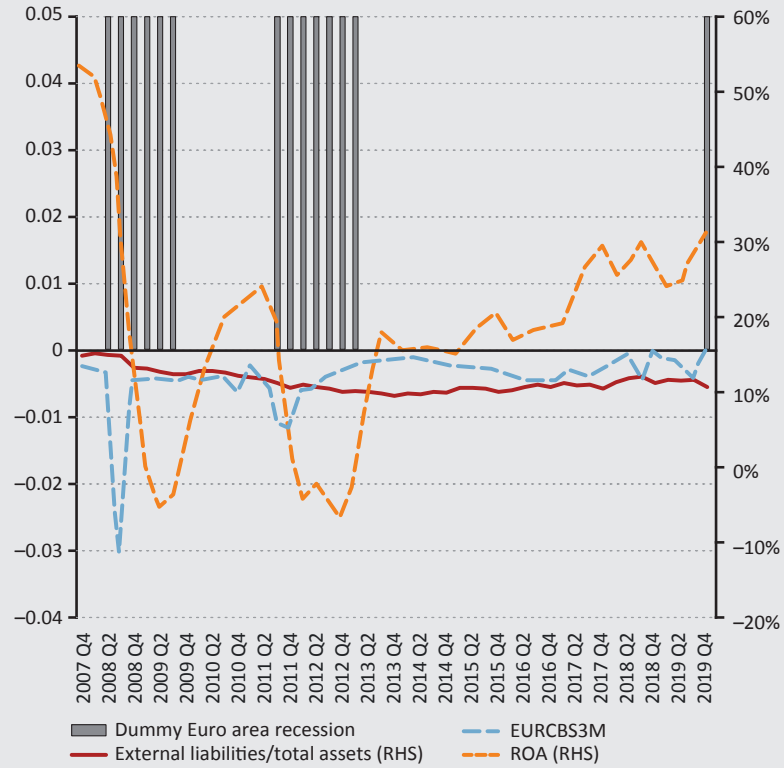


Note: Rectangles represent recession quarters.
Source: Plotted based on ECB's data

Figure 3 shows that the peak in allocated dollar liquidity fell predominantly on 2008 and 2010 followed by a second wave from late 2011 to mid-2014, and then stabilised at a low level after 2015. Parallel to this, the ECB's lending and securities purchasing activity increased markedly in the first half of 2010, but it is clearly visible how the $\frac{L_t + S_t}{FX_t}$ - indicator started to increase significantly in the first half of the decade following the QE announcement.

The drop in the value of return on assets shown in *Figure 4* closely followed the fluctuations in economic cycles, while the ratio of the banking sector's external resources to total assets declined steadily over the period under review, from an initial 15 per cent to close to 10 to 11 per cent. It is clearly visible that dollar funding disruptions typically emerged at the beginning of the recession periods, but the 3-month EUR-USD basis swap remained negative throughout.

Figure 4
Values of market variables included in the model



Source: Plotted based on Refinitiv Eikon, European Commission and ECB

3.2. Methodology

Vector autoregressive (VAR) processes characterise the data generation process of a smaller amount of time series variable, where a priori endogeneity is assumed for each variable and their dynamics are taken into account. This procedure records the dynamic interactions of a set of time series variables of *N* number: $y_t = (y_{1t},\ldots, y_{Kt})'$. The basic VAR model can be described in the following reduced form (2) based on *Lütkepohl – Kratzig* (*2004*):

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t, \qquad (2)$$

where y_t is the (*Nx1*) vector containing the model variables, F_i is a matrix containing (*NxN*) *autoregression coefficients*, and $\varepsilon_t = (u_{1t},\ldots, u_{Kt})'$ is the unobserved error term, which is a vector with (*Nx1*) Gaussian distribution containing a discrete representation white noise process and $\varepsilon_t \sim (0, E(u_t, u_t'))$ is a positive definite covariance matrix. Weak stationarity is expected for input variables, while the

error terms of the equation lack autocorrelation (Ljung–Box p > 0.05 for each time lag or 1.85 < Durbin–Watson < 2.15) and normal distribution (Jarque–Bera-test p > 0.05) is desirable.

When writing equation (2), several restrictions of the parameters are conceivable: in the case of Cholesky's writing, the short-term restriction can be used to describe the sequence of shocks, while with Blanchard–Quah's long-term restriction, the appearance of the shock can be described. To do this, we first need to introduce the structural (3) version of the reduced VAR form (with a time lag *p* and three variables with structural coefficients A and A^s):

$$Ay_t = A_1^s y_{t-1} + \cdots + A_p^s y_{t-p} + Bu_t, \text{ where } \varepsilon_t = A^{-1}Bu_t \text{ and } S = A^{-1}B. \quad (3)$$

In Cholesky's restriction (4), we assume that the value of certain coefficients is zero and u_{1t} immediately affects the other variables concurrently, while u_{2t} affects only variables 2 and 3 concurrently, and u_{3t} only the third:

$$\varepsilon_t = Su_t = \begin{bmatrix} s_{11} & 0 & 0 \\ s_{21} & s_{22} & 0 \\ s_{31} & s_{32} & s_{33} \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix}. \quad (4)$$

By contrast, in the long-term restriction of *Blanchard – Quah* (*1989*) (5), the shock is searched for only in the row of the *F*-matrix where the variable appears, and the cumulative long-term effect of the shock is zero and Ψ the long-term multiplier (*F* = Ψ*S*) is:

$$\left(I - A_1 - \cdots - A_p\right)^{-1}\varepsilon_t = \Psi\varepsilon_t = Fu_t \text{ and } F = \begin{bmatrix} f_{11} & 0 & 0 \\ f_{21} & f_{22} & 0 \\ f_{31} & f_{32} & f_{33} \end{bmatrix}, \text{ while } S = \begin{bmatrix} s_{11} & s_{12} & s_{13} \\ s_{21} & s_{22} & s_{23} \\ s_{31} & s_{32} & s_{33} \end{bmatrix}. \quad (4)$$

The structure of the F-matrix describing long-term effects (*Table 1*) when using the Eviews programme determined the order of the variables loaded into the VAR model[19] at the same time – given that there will be a shock that will affect each variable, and the variable at the end of the sequence will be the one that only affects itself. Shocks from the dollar liquidity-providing tenders of the ECB as the leading central bank should affect the other variables included in the model, otherwise their effectiveness would be questionable. However, in the long run the shocks of the EUR-USD basis swap rate can no longer have a significant effect on the development of the amount lent ($f_{12}=0$). For the shocks of the banking system's exposure outside the euro area, the swap rate and the ECB's liquidity lending can be interpreted as externalities, therefore their long-term impact can be considered

[19] In our case this means running the following script:
var var1.ls 1 5 dkih_usd deurcbs3m dez_kivuli_forras dlsfx droa @ c dummy_ez_rec dummy_outlier

zero ($f_{13}=0$, $f_{23}=0$). The change in the asset-side structure of the central bank's balance sheet maps the use of the full, conventional and non-conventional toolbox (excluding possible changes in leverage), but by its nature this cannot describe either the development of dollar liquidity, the swap rate or the external exposure of the banking system ($f_{14}=0$, $f_{24}=0$, $f_{34}=0$). In the normal course of business, the goal is not to consider the banking system's return on assets (*ROA*) in the long run in terms of conducting monetary policy or market financing conditions ($f_{15}=0$, $f_{25}=0$, $f_{35}=0$, $f_{45}=0$).

Table 1
Structure of F-matrix containing long-term effects

		shock				
		$\Delta\frac{K_{USD,t}}{\sum K_{USD}}$	$\Delta\frac{bS_{3M,\frac{EUR}{USD}}}{100}$	$\Delta\frac{L_{nEZ,t}}{TL_t}$	$\Delta\frac{L_t+S_t}{FX_t}$	ΔROA_t
variable	$\Delta\frac{K_{USD,t}}{\sum K_{USD}}$	f_{11}	0	0	0	0
	$\Delta\frac{bS_{3M,\frac{EUR}{USD}}}{100}$	f_{21}	f_{22}	0	0	0
	$\Delta\frac{L_{nEZ,t}}{TL_t}$	f_{31}	f_{32}	f_{33}	0	0
	$\Delta\frac{L_t+S_t}{FX_t}$	f_{41}	f_{42}	f_{43}	f_{44}	0
	ΔROA_t	f_{51}	f_{52}	f_{53}	f_{45}	f_{55}

Impulse response functions are the effect of a unit shock on a given model variable, where the shock of variable *i* to variable *j*, *ceteris paribus*, is simply the order of the elements in row *i* and column *j*, in the $C_k = \frac{dy_t}{d\varepsilon_{t-k}}$ matrix.

The variance decomposition makes it possible to determine which shocks are decisive in the short- and long-term evolution of certain variables, i.e. the proportion of the uncertainty of variable *i* that can be attributed to the j^{th} shock after period *h*:

$$\mathcal{VD}_{i,j,h} = \frac{\sum_{k=0}^{h}\left(kc_{i,j}\right)^2}{\sum_{k=0}^{h}\sum_{l=1}^{n}\left(kc_{i,l}\right)^2}.$$

4. Results

The results of the calculations based on the theoretical model are presented in three steps: first we present the basic statistics of the logarithmic changes of the input variables, then we present the equations obtained from VAR fittings and the results of tests examining non-autocorrelation and the normal distribution of error terms. Finally, the resulting impulse response functions and variance decompositions are plotted.

4.1. Basic statistics

As can be seen from *Table 2*, only stationary variables were included in the VAR model, which in some cases proved to be of normal distribution. Dummy variables are designed to compensate for the outstanding kurtosis of lent dollar liquidity and the foreign currency basis swap.

Table 2
Basic statistics of input variables

Test	Central momentums				Normal distribution	Auto-correlation	Hetero-scedasticity	Unit-root
variable	average	skewness	peakedness	kurtosis	Jarque–Bera (p)	Ljung–Box (p)	ARCH-LM (p)	ADF (p)
$\Delta\frac{K_{USD,t}}{\sum K_{USD}}$	0.0000	0.0468	1.8711	20.8573	0.0000	0.4482	0.6911	0.0000
$\Delta\frac{L_{nEZ,t}}{TL_t}$	–0.0049	0.0507	0.0019	2.6201	0.7937	0.2202	0.1994	0.0039
ΔROA_t	–0.0044	0.0618	–1.2076	5.7197	0.0000	0.0000	0.0014	0.0022
$\Delta\frac{L_t+S_t}{FX_t}$	0.0494	0.2606	0.0852	2.3245	0.5453	0.0157	0.0232	0.0001
$\Delta\frac{bS_{3M,\frac{EUR}{USD}}}{100}$	0.0035	0.5821	–0.2699	18.5860	0.0000	0.0044	0.3041	0.0000

Source: Plotted with Matlab2014a MFE toolbox

4.2. VAR model

The time lag of the VAR model was determined partly based on the information criteria (Schwarz IC recommended a 5-quarter time lag) and partly based on the normal distribution and non-autocorrelation of the error terms. AIC and HQ criteria suggested a 6-quarter time lag, but those models did not have normally distributed error terms, therefore we opted for the 5-quarter time lag model.

As shown in *Table 3*, the LM-test testing autocorrelation shows that the error terms of the VAR equation meet the requirements for non-autocorrelation, and their distribution is also normal based on the Jarque–Bera test. The S and F-matrices of the structural model are contained *in Table 4 of the Annex*.

Table 3
Examination of error terms of the two VAR equations: non-autocorrelation and normal distribution

		time lag	p-value
LM-test	h-time lag	1	0.3037
		2	0.9204
		3	0.7095
		4	0.8209
		5	0.2207
		6	0.8137
	1:h time lag	1	0.3037
		2	0.4463
		3	NA
		4	NA
		5	NA
		6	NA
Jarque–Bera		Joint	0.7959

Note: NA: No data available
Source: Plotted with Eviews 11 software

4.3. Impulse response functions and variance decomposition

The cumulative impulse response functions calculated using the long-term restrictions used in the structural VAR model (*Figure 5*) show a negative effect of the change in non-euro area liabilities in commercial bank balance sheets losing significance after 5 quarters, in addition to the ongoing self-stimulating change in dollar lending – the increase in the ratio was accompanied by declining use of ECB's dollar auctions. That is, in such cases, the banking sector was able to finance itself on market basis. Although the declining value of foreign currency basis swaps suggests an increase in dollar market tensions, in the first quarter the lending had a counter-intuitive sign[20]. An increase in return on assets (ROA) over 3 quarters will result in a decrease in tendered dollar liquidity. The expansion of non-conventional lending and securities purchase programs ((*L+S*)/*FX*) is accompanied by a decline in dollar liquidity placement in addition to the 4-quarter time lag, suggesting that dollar liquidity placements had already been over when securities market programs rose. Based on the results obtained, the assumptions of the model can only be interpreted in the long run to a significant extent with a time lag of a few quarters. The VAR model was also fitted with several alignments of the F-matrix, but qualitatively similar results to those above were obtained.

[20] The variable retained this property even with multiple writings of the structural F-matrix, so this result can be considered robust.

Figure 5
Cumulated impulse response functions of the structural VAR model

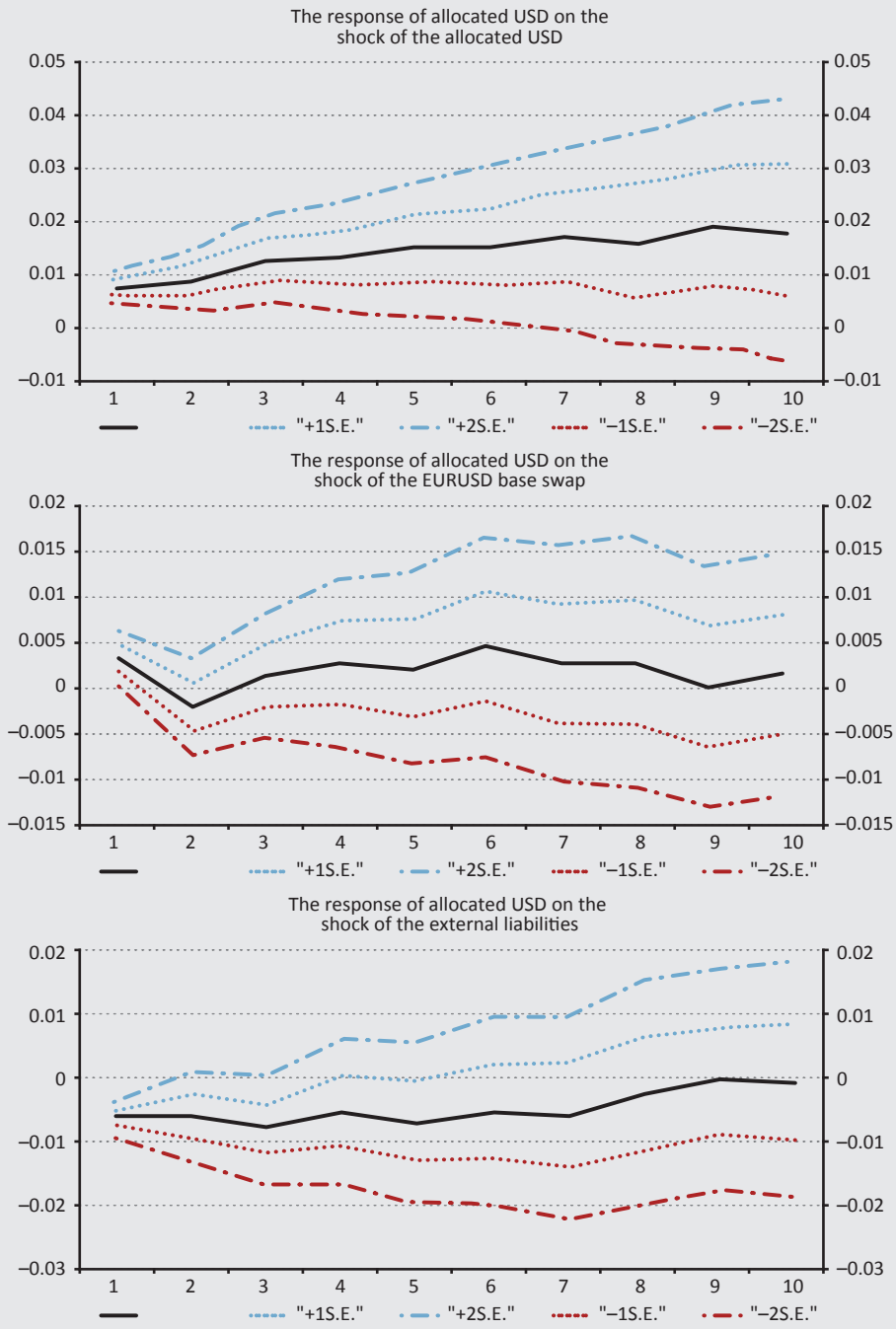
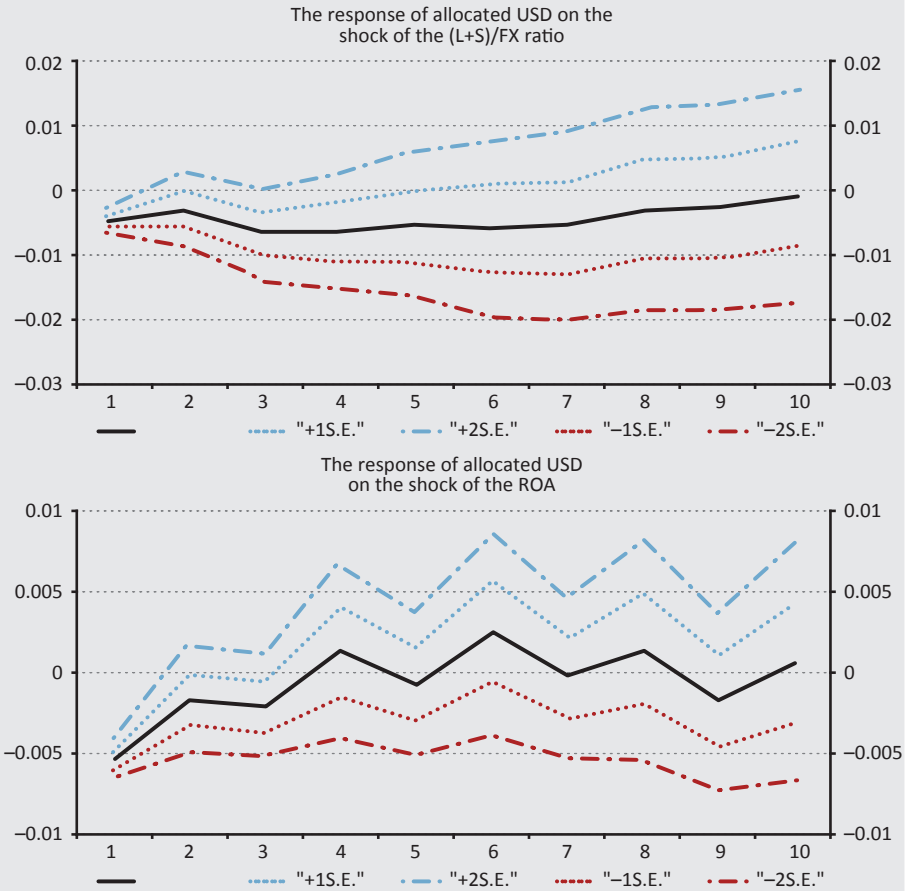


Figure 5
Cumulated impulse response functions of the structural VAR model

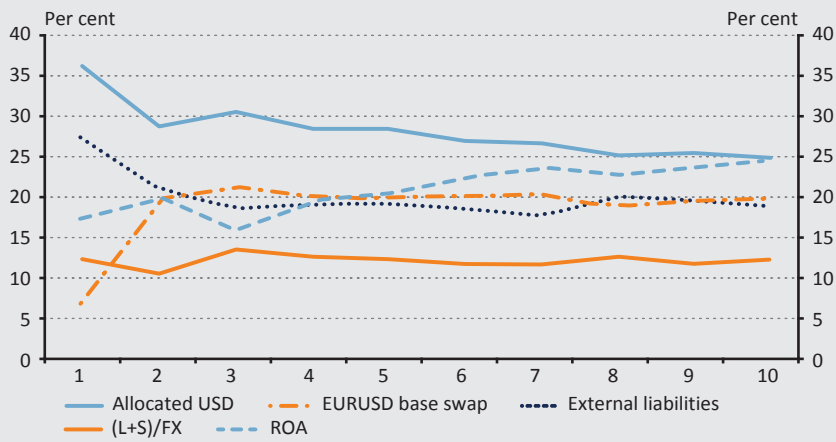


Note: Black solid lines indicate impulse response functions, while 68% (±1 S.E.) and 95% (±2 S.E.) confidence intervals based on Albrizio et al. (2020).

Source: Plotted with Eviews11 software

Based on the variance decompositions performed (*Figure 6*), the variance of the change in dollar liquidity provided by the ECB has been affected by the variables in the model for several quarters, to almost 70 per cent. The weight of non-euro-area funds declines from an initial 27 per cent to close to 20 per cent in the second quarter, which is similar to the weight of changes in the basis swap and ROA. Meanwhile, the importance of the central bank's balance sheet structure remained between 10 and 15 per cent throughout.

Figure 6
Variance decomposition of the structural VAR model



Source: Plotted with Eviews11 software

5. Summary

In the course of our work, we first reviewed the agreements that led to each leading central bank providing one another with foreign currency liquidity after December 2007 in order to fulfil their role as the "last resort" in supplying adequate foreign currency liquidity. We then outlined our theoretical model and described the data included in the study. We analysed the statements made in the model using structural vector autoregression that examines long-term correlations.

Overall, the model we have written has been validated with euro area credit institutions turning to the ECB for dollar-denominated foreign currency liquidity mainly when it has become difficult to raise funds outside the euro area, their return on asset ratios have declined, or tensions have emerged in the dollar market. Parallel to this, the impact of euro-denominated lending and securities accumulation was also felt. This means we can also confirm the theoretical expectations formulated in connection with the theoretical model, according to which, due to market

disturbances and the freezing of traditional channels of international capital flows, credit institutions really needed foreign currency funds available through swap lines between central banks.

It seems that this market failure was not limited exclusively to the period of the 2007-2009 global financial crisis, but the effects can also be revealed in a sample describing the last 12 years. This is suggested by the fact that although leading central banks have made several attempts to suspend interbank swap lines, citing the temporary drying-up of credit institutions' foreign currency liquidity needs, these programs had to be relaunched several times and today they are now largely part of normal business operations. This also well illustrates the process where the philosophy and toolbox of "unconventional" monetary policy, initially considered temporary, have now become dominant in the operation of the world's central banks.

References

Ács, A. (2011): *A likviditás dimenziói* (*Dimensions of Liquidity*). Hitelintézeti Szemle, 10(3): 241–261.

Aizenman, J. – Cheung, Y-W. – Qian, X. (2020): *The currency composition of international reserves, demand for international reserves, and global safe assets*. Journal of International Money and Finance, 102(April): 102120. https://doi.org/10.1016/j.jimonfin.2019.102120

Albrizio, S. – Choi, S. – Furceri, D. – Yoon, C. (2020): *International bank lending channel of monetary policy*. Journal of International Money and Finance, 102(April): 102124. https://doi.org/10.1016/j.jimonfin.2019.102124

Aldasoro, I. – Ehlers, T. – Eren, E. (2019): *Global Banks, Dollar Funding, and Regulation*. BIS Working Papers No 708, Bank of International Settlements, May. https://doi.org/10.2139/ssrn.3368973

Allen, F. – Babus, A. (2009): *Networks in Finance*. In: Kleindorfer, P. – Wind, J. – Gunther, R.E. (eds.): Network Challenge, The Strategy, Profit, and Risk in an Interlinked World, Pearson Prentice Hall, pp. 367–382. https://doi.org/10.2139/ssrn.1094883

Allen, W.A. – Moessner, R. (2010): *Central bank co-operation and international liquidity in the financial crisis of 2008-9*. BIS Working Papers No 310, Bank of International Settlements. https://doi.org/10.2139/ssrn.1631791

Alvarez, I. – Casavecchia, F. – De Luca, M. – Duering, A. – Eser, F. – Helmus, C. – Hemous, C. (2017*): The Use of the Eurosystem's Monetary Policy Instruments and Operational Framework since 2012*. ECB Occasional Paper 188, European Central Bank. https://doi.org/10.2866/112727

Ananda, K. – Gaib, P. – Marsilid, M. (2012): *Rollover risk, network structure and systemic financial crises*. Journal of Economic Dynamics and Control, 36(8): 1088–1100. https://doi.org/10.1016/j.jedc.2012.03.005

Antal, J. – Gereben, Á. (2011): *Foreign reserve strategies for emerging economies – before and after the crisis.* MNB Bulletin, 2011(1): 7–19. https://www.mnb.hu/letoltes/antal-gereben-eng.pdf

Avdjiev. S. – Subelyte, A. – Takáts, E. (2016): *The ECB's QE and euro cross-border bank lending*. BIS Quarterly Review, Bank for International Settlements, September. https://www.bis.org/publ/qtrpdf/r_qt1609h.htm. Downloaded: 10 March 2020.

Baker, C. (2013): *The Federal Reserve's Use of International Swap Lines*. Arizona Law Review, 55: 603–654. https://doi.org/10.2139/ssrn.2226708

Banai, Á. – Kollarik, A. – Szabó-Solticzky, A. (2015): *Topology of the foreign currency/forint swap market.* Financial and Economic Review, 14(2): 128–157. https://en-hitelintezetiszemle.mnb.hu/letoltes/5-banai-kollarik-szabo-en.pdf

Berlinger, E. – Michaletzky, M. – Szenes, M. (2011): *A fedezetlen bankközi forintpiac hálózati dinamikájának vizsgálata a likviditási válság előtt és után* (*Examination of the network dynamics of the uncovered interbank forint market before the liquidity crisis and after*). Közgazdasági Szemle (Economic Review), 58(March): 229–252.

BIS (2011): *Global liquidity - concept, measurement and policy implications*. BIS CGFS Publications No 45, Bank of International Settlements, November. https://www.bis.org/publ/cgfs45.pdf. Downloaded: 10 March 2020.

Blanchard, O.J. – Quah, D. (1989): *The Dynamic Effects of Aggregate Demand and Supply Disturbances*. The American Economic Review, 79(4): 655–673.

Bordo, M.D. – Humpage, O.F. – Schwartz, A.J. (2015): *The Evolution of the Federal Reserve Swap Lines since 1962*. IMF Economic Review, 63(2): 353–372. https://doi.org/10.1057/imfer.2015.11

Brophy, T. – Herrala, N. – Jurado, R. – Katsalirou, I. – Le Quéau, L. – Lizarazo, C. – O'Donnell, S. (2019): *Role of cross currency swap markets in funding and investment decisions*. ECB Occasional Paper Series No 228, European Central Bank, August. https://www.ecb.europa.eu//pub/pdf/scpops/ecb.op228~bb3e50120a.en.pdf. Download date: 10 March 2020.

Csávás, Cs. – Szabó, R. (2010): *A forint/deviza FX-swap szpredek mozgatórugói a Lehman-csőd utáni időszakban* (*Determinants of Hungarian forint FX swap spreads after the Lehman crisis*). Hitelintézeti Szemle, 9(6): 566–580.

Destais, C. (2016): *Central Bank Currency Swaps and the International Monetary System*. Emerging Markets Finance and Trade, 52(10): 2253–2266. https://doi.org/10.1080/1540496X.2016.1185710

ECB (2008): *EU Banking Structures*. European Central Bank, October. https://www.ecb.europa.eu/pub/pdf/other/eubankingstructures2008en.pdf. Downloaded: 10 March 2020.

ECB (2019): *The international role of the euro*. European Central Bank, June. https://www.ecb.europa.eu/pub/ire/html/ecb.ire201906~f0da2b823e.en.html. Downloaded: 2 April 2020.

Engelberth, I. – Sági, J. (2017): *Role and objectives of the New Silk Road initiative.* Foreign Policy Review, 16(3): 85–104.

Frankel, J. (2011): *Monetary Policy in Emerging Markets*. In: Friedman, B.M. – Woodford, M. (eds.): Handbook of Monetary Economics. Elsevier, pp. 1441–1499.

Ivashina, V. – Scharfstein, D S. – Stein, J.C. (2015): *Dollar Funding and the Lending Behavior of Global Banks*. Quarterly Journal of Economics, 130(3): 1241–1281. https://doi.org/10.1093/qje/qjv017

Kick, T. – Koetter, M. – Storz, M. (2018): *Cross-border transmission of emergency liquidity*, Journal of Banking and Finance, 113: 105300. https://doi.org/10.1016/j.jbankfin.2018.02.006

Kiss, G.D. – Ampah, I.K. (2018): *Macroeconomic Volatility and Capital Flights in Sub-Saharan Africa: A Dynamic Panel Estimation of some Selected HIPC Countries*. Mediterranean Journal of Social Sciences, 9(5): 165–176. https://doi.org/10.2478/mjss-2018-0148

Lütkepohl, H. – Kratzig, M. (2004): *Applied Time Series Econometrics*. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511606885

Madura, J. (2008): *International Financial Management.* Thompson.

Mák, I. – Páles, J. (2009): *The role of the FX swap market in the Hungarian financial system.* MNB Bulletin, 2009(5): 24–34. https://www.mnb.hu/letoltes/mak-pales-en.pdf

Obstfeld, M. – Shambaugh J. C. – Taylor, A. M. (2009): *Financial Instability, Reserves, and Central Bank Swap Lines in the Panic of 2008*. American Economic Review, 99(2): 480–486. https://doi.org/10.1257/aer.99.2.480

Páles, J. – Kuti, Zs. – Csávás, Cs. (2010): *The role of currency swaps in the domestic banking system and the functioning the swap market during the crisis.* MNB Occasional Papers 90, Magyar Nemzeti Bank. https://www.mnb.hu/letoltes/op-90.pdf

Pelle, A. – Végh, M. (2019): *Hogyan változott az euróövezet a kezdetek óta?* (*How has the Eurozone Changed Since its Inception?*) Pénzügyi Szemle (Public Finance Quarterly), 64(1): 127–145.

Seghezza, E. (2018): *Can swap line arrangements help solve the Triffin dilemma? How?* The World Economy, 41(10): 2691–2708. http://doi.org/10.1111/twec.12669

Takáts, E. – Temesvary, J. (2020): *The currency dimension of the bank lending channel in international monetary transmission*. Journal of International Economics, 125(7): 103309. http://doi.org/10.1016/j.jinteco.2020.103309

Annex

Maximum likelihood via Newton-Raphson (analytic derivatives)
Model: e = Phi*Fu where E[uu']=I

Table 4
Result of structural VAR-estimate

F =				
C(1)	0	0	0	0
C(2)	C(6)	0	0	0
C(3)	C(7)	C(10)	0	0
C(4)	C(8)	C(11)	C(13)	0
C(5)	C(9)	C(12)	C(14)	C(15)
	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
C(1)	0.024857	0.002650	9.380826	0.0000
C(2)	0.011785	0.010943	1.076922	0.2815
C(3)	0.019235	0.004873	3.947205	0.0001
C(4)	0.625060	0.097028	6.442088	0.0000
C(5)	0.005552	0.003701	1.500050	0.1336
C(6)	0.072107	0.007687	9.380829	0.0000
C(7)	–0.022397	0.003721	–6.019773	0.0000
C(8)	–0.052148	0.070311	–0.741673	0.4583
C(9)	0.018413	0.003082	5.975096	0.0000
C(10)	0.018928	0.002018	9.380830	0.0000
C(11)	0.335420	0.060285	5.563905	0.0000
C(12)	–0.011781	0.002017	–5.842328	0.0000
C(13)	0.321955	0.034321	9.380830	0.0000
C(14)	–0.004081	0.001517	–2.690743	0.0071
C(15)	0.009637	0.001027	9.380830	0.0000
Log likelihood	**362.9767**			
Estimated S matrix:				
0,007579	0.003314	–0.006604	–0.004399	–0.005283
–0,037969	0.160091	–0.082201	–0.094112	0.026249
0,012097	–0.015354	0.003329	–0.027091	0.002315
0,119286	0.068561	0.135037	0.081387	0.003683
0,009802	0.013461	–0.011657	–0.000911	0.010490
Estimated F matrix:				
0,024857	0.000000	0.000000	0.000000	0.000000
0,011785	0.072107	0.000000	0.000000	0.000000
0,019235	–0.022397	0.018928	0.000000	0.000000
0,625060	–0.052148	0.335420	0.321955	0.000000
0,005552	0.018413	–0.011781	–0.004081	0.009637

Source: Calculations performed with Eviews11 software

Risks of Climate Change and Credit Institution Stress Tests*

Eszter Boros

Climate change is one of the greatest challenges of our time, even in the short term, and financial institutions will not escape its economic effects either. Focusing on the key players of the Hungarian financing model, i.e. commercial banks, the essay reviews how the risks associated with climate change can be assessed in the context of stress tests. To do this, it considers the most recent literature on the topic and aspects that have emerged in analyst practice. The discussion of the connected issues of this special stress testing process contributes to developing the framework of domestic bank climate stress tests, to identifying the most important challenges, and it provides guidelines for their management. The most significant revealed difficulties are the accurate capturing of climate shocks and identifying their macroeconomic channels. In addition, the transformation of standard banking risk models may also require significant work.

Journal of Economic Literature (JEL) codes: C51, C58, G17, G21, Q56

Keywords: sustainable finance, climate change, carbon neutral transition, stress test, risk management

1. Introduction

Today, climate change has also become an important topic for central banks, supervisory authorities and financial markets. The Bank of England (BoE), the European Central Bank (ECB), the US Federal Reserve (Fed) and other organisations are also emphasising the extent of the threat to humanity and the role of the financial intermediary system in tackling the problem. Christine Lagarde, former head of the International Monetary Fund (IMF) and current head of the ECB, drew attention to the risks of postponing climate actions even before the new boost for the global climate movement. In her indicative words, "unless we take action on climate change, future generations will be roasted, toasted, fried and grilled" (quoted by *Marshall 2014: 5*9). Similar statements have been heard by the public in recent years from Mark Carney, former BoE governor, who described climate change

* 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 Hungarian manuscript was received on 25 May 2020.

DOI: http://doi.org/10.33893/FER.19.4.107131

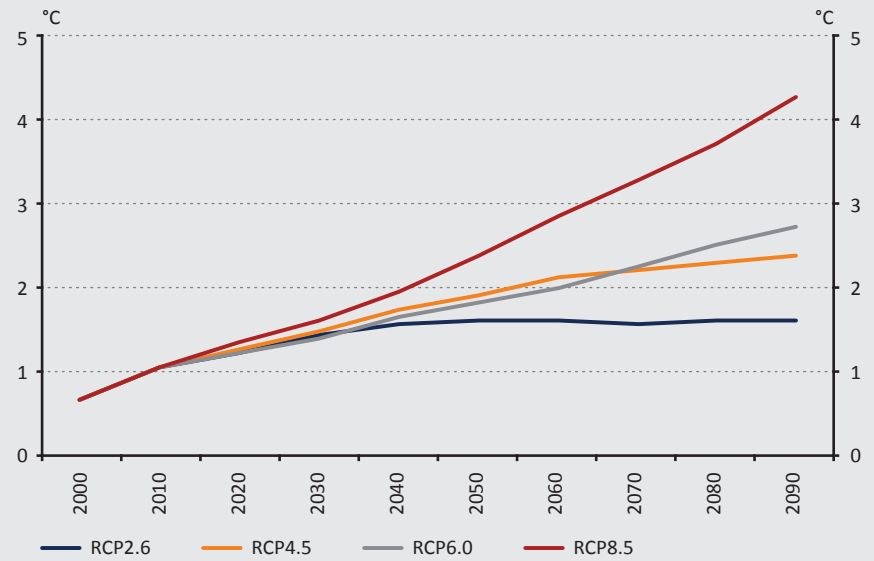
as “a tragedy of the horizon”. By this, he referred to the common dilemma where the present motivations are not in line with socio-economic outcomes that would be optimal in the long run.[1] Nevertheless, climate change is not just a possibility of a *future catastrophe*: more and more people are pointing out that it will have serious effects even *in the short term*. This may be particularly true for financial markets, as the assets involved can be repriced quickly (*Rudebusch 2019*). More broadly, we are already seeing more and more phenomena today that are “by-products” of the carbon-based economy aimed at infinite growth. These include weather emergencies, but also threats related to large-scale livestock farming and global tourism, such as the increased risk of pandemics (cf. *Harari 2015*; *Staden 2020*).

It is no coincidence that the main common thread in the statements of key financial managers is time horizon. Namely, climate change is a complex process, whose understanding requires a long time, while risk management must already be considered in the short term. Climatic events tend to unfold in full over decades, causing great uncertainty in the present. However, many think the measures taken to control the harmful processes are already late, and they call for immediate drastic action to achieve the so-called Paris climate targets (see *UN*[2]*, BoE 2019*).

The *Paris Climate Agreement* (*UN 2015*) set the goal that the increase in the average temperature of the Earth must not reach +2°C compared to temperatures experienced before the industrial revolution. To this end, the 95 signatory countries and the European Union have made significant commitments to limit greenhouse gas (GHG) emissions. This is because in the absence of such measures, the coming decades could bring significant warming. According to the scenarios of the United Nations International Panel on Climate Change (IPCC), failure to take appropriate action could lead to a rise in temperature of more than +4°C by the end of the century (*IPCC 2013*). *Figure 1* shows the warming scenarios outlined by the IPCC that correspond to certain greenhouse gas concentration trajectories (representative concentration pathways, RCPs). To achieve lower temperature pathways, humanity must significantly reduce its CO_2 emissions (decarbonisation). For lack of this, a rise in average temperature may result in an increase in heat-related deaths, vegetation transformation, and changes in agricultural yields, to name just a few possible consequences (*Burke et al. 2015; UNEPFI 2018a; Gallic – Vermandel 2019*).

[1] *Breaking the Tragedy of the Horizon – Climate Change and Financial Stability*. Speech by the Governor of the Bank of England on 29 September 2015. https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability. Downloaded: 2 April 2020.
[2] *Climate Change*. https://www.un.org/en/sections/issues-depth/climate-change/. Downloaded: 2 April 2020.

Figure 1
Possible scenarios for global average surface temperature increase (increase compared to pre-industrial temperatures)



Note: RCP (representative concentration pathway): greenhouse gas concentration trajectories adopted by the IPCC. The figure shows the corresponding expected changes in temperature.

Source: Plotted based on IPCC (2013) data

The decarbonisation process also affects banks, in fact, they are key players in it. This is because credit institutions[3] indirectly have a significant impact on the state of our planet through their business decisions. Financed companies, investments, projects and real estates can be very different from an environmental perspective (*UNEPFI 2018b*). They differ in their emissions (carbon intensity) both in terms of their own economic activity/operation and the supply chain that covers them. Therefore the exposures in banks' books carry different risks from a climate perspective too: they may react differently to environmental, environmental policy and technological developments. Some financed clients (such as agricultural businesses) may be more vulnerable to weather events. Other debtors may be more sensitive to the regulatory and technological process of the transition to a carbon-neutral economy (fossil fuel power plants, manufacturers of internal combustion engines and vehicles, etc.). Thus through their clients, banks also face the effects of climate change, which, similar to other risks, can jeopardise their profitability and capital position, and thereby ultimately the stability of the financial intermediary system (*NGFS 2019; Feyen et al. 2020*). To ensure sound banking it is now clear that credit institutions

[3] In the essay, the terms "credit institution" and "bank" are used interchangeably.

must also take these factors into account in their risk management.[4] In addition to the general principles of prudent operation, the consideration of climate change effects is already envisaged by international recommendations (Financial Stability Board, Task Force on Climate Related Financial Disclosures, *FSB – TCFD 2017*). In Hungary, the measures identified by the National Energy and Climate Plan (NECP) (*ITM 2020*) and the financial stability focus points of the Central Bank of Hungary (Magyar Nemzeti Bank, MNB) (*MNB 2019*) also encourage credit institutions to prepare to identify the vulnerabilities that may emerge during decarbonisation.

However, it is a great challenge for banks to capture and analyse these "unusual" risk factors. In recent years, a number of research projects as well as pioneering work and initiatives of banks and the central banks have been carried out to assess the effects of climate change on credit institutions and develop the necessary toolbox (e.g. *BoE 2018; Vermeulen et al. 2018; MNB 2019*). Even so, the topic is still considered new to most financial institutions in the world, including Hungarian banks. The aim of this essay is to contribute to the development of Hungarian bank climate stress testing practice by providing a comprehensive explanation of a possible framework. It is based on the widely used structure of credit institution stress tests and determines the main aspects and challenges arising from the application of climate shocks. The article is structured as follows: *Chapter 2* discusses the key concepts and basic considerations required for climate stress testing, and then outlines the overall structure of the stress test. *Chapter 3* deals with the building blocks of this, focusing on integrating climate change. *Chapter 4* summarises the conclusions.

2. Bank stress tests and climate change

The bank stress test is a complex quantitative analysis to assess how credit institutions would withstand severe economic downturns and shocks (*Quagliariello 2009; Borio et al. 2014*).[5] Over the applied time horizon, the expected trajectory of bank exposures, profitability and own funds according to a given scenario can be simulated by means, and with the assumptions, of the stress test.

[4] Of course, economic processes related to climate change also carry business opportunities, and banks can actively shape their portfolios to seize these opportunities by selecting the right companies. This enables them to have a broader impact: by financing climate-friendly investments and companies, they can make their own contribution to mitigating climate change. An analysis of these strategies and effects would require dedicated research – this essay focuses on measuring risks.

[5] The stress test can be macro-level (covering the entire banking system) or it can examine a single bank (*Quagliariello 2009*). The former types of test are typically performed by central banks and other systemic risk assessment organisations, while individual-level tests are typically carried out by supervisory bodies and the credit institutions themselves. Macro-level tests may also be able to provide a forecast for individual banks. From the point of view of the essay it does not matter who performs the stress test, it should only be noted that we use stress tests that are (also) suitable for quantifying individual banking effects.

Even this brief definition reflects why the essay chooses stress tests from a wide range of risk measurement tools to examine climate factors. Namely, stress tests allow for a complex analysis of a bank's situation, i.e. they primarily represent a framework, a comprehensive "apparatus" into which several specific models fit (or can be incorporated). In addition, the method has been developed precisely to examine different future scenarios, so by its design and purpose it may be suitable for tracking the trajectories of climate change. As stress testing has been widespread in the practice of banks, central banks and supervisory authorities since the 2007–2008 crisis, and even regulations based on Basel standards require its regular application, institutions do not need to develop a new tool for assessing climate risks. It is enough to adjust existing approaches, although this is a major challenge – precisely due to the particularities of climate change.

Climate change differs significantly from the most commonly modelled "traditional" shocks. Stress tests usually start from economic shocks for which experience and data are already available. Economists can determine their characteristics, the channels through which they ripple into the economy (such "usual" shocks can include, for example, an increase in oil prices, a tax increase, a shift in demand). The occurrence and course of these can naturally be predicted to a limited extent only (cf. *Taleb 2007*), but past experience can still reduce the uncertainty: they turn it into a quantifiable risk. For the sake of simplicity, the dangers of climate change are also referred to as "risk", but the phenomenon in fact carries much more uncertainty than normal. Atmospheric and environmental impacts are extremely complex and have a very multi-faceted correlation with human activities. Moreover, interactions tend to unfold usually only over a longer period. Due to all this, today we still have relatively little knowledge and experience about the transformation of ecosystems, and translating the existing physical-ecological knowledge into the language of economics and finance also remains a problem. So intense thinking on climate stress tests is currently under way among financial institutions around the world and their stakeholders.

The recognition that climate risks can basically be divided into two groups (*UNEPFI 2018a, 2018b; NGFS 2019*) helps to capture them. Physical risks arise from the underlying process itself, from the atmospheric and environmental transformation. Thus, they represent the risk of losses caused by phenomena attributable to climate change (such as climatic disasters). These may directly affect the facilities and employees of banks, but the damage to the financed economic entities endangering their solvency is of even greater importance. A more precise definition of the physical risks to a geographical area requires primarily scientific or sectoral (such as agricultural) expertise.

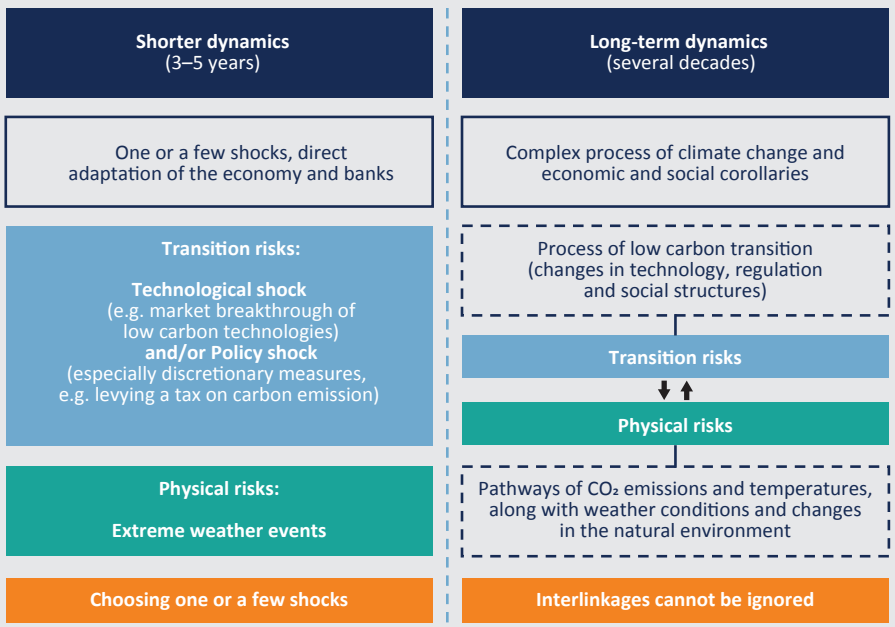
Another large group of climate risks are called transition risks. This is not about climate change itself, but about the effects of the measures taken to prevent and mitigate it. Transition risks therefore include shocks arising from the technological and policy/regulatory transition to a low-carbon economy. The transformation of the fossil economy requires multiple government interventions (taxes, subsidies, government purchases, etc.) and technological change that could, at least in the short term, adversely affect a significant number of economic actors. The most obvious examples are coal mines, oil producers, fossil energy producers, vehicle manufacturers and airlines, but in reality, through the amounts of CO_2 embodied in products and services, the entirety of modern economies are involved in the process. (It is precisely this CO_2 amount that could be the basis for determining vulnerability in modelling, see *BlackRock 2015; Vermeulen et al. 2018.*) The involvement of banks primarily depends on the composition of their portfolios. Knowledge of the region's/country's climate strategies, development plans and technological trends are most needed to specify transition risks. At the same time, despite the environmental commitments already made by governments and companies, the decarbonisation transition may not necessarily take place, or it may take place in a disorderly and uncontrolled manner. A delayed, disorderly transition is obviously much more unpredictable and entails greater shocks: fractures such as a panic repricing of assets, a rapid decline in the market capitalisation of some companies, or even state bankruptcies (*Battiston - Monasterolo 2019*). Transition and physical risks certainly correlate: the later and the more disorderly the transition attempt, the greater the chance of unfavourable temperature outcomes.

The demarcation of the two types of risk helps to choose the time horizon of the analysis. As already emphasised, one of the main challenges in integrating climate change into bank stress tests is the time horizon. "Normal" stress tests used in bank risk management typically look at shorter periods (3–5 years) as they are designed to provide information about the direct course of a shock. Relying on this toolbox, a significant proportion of existing climate stress tests continue to use the shorter horizon (for example *Vermeulen et al. 2018; Stamate – Tatarici 2019*). However, some approaches under development (*BoE 2019; NGFS 2019*) intend to take a long-term horizon into account, up to several decades, in line with the dynamics of weather events and the transition process.

Figure 2 illustrates a possible demarcation between the short and long term as two options for analysis. In the case of a shorter horizon, we can model the effect of a specific shock in line with the established stress testing practice. To do this, one or a few events must be selected from the transition/physical risks. These shocks can be translated relatively easily into the language of standard macroeconomics

(for example: cost shock, demand shock, supply shock). (Scenarios are discussed in detail in the next chapter.) The ease of short-term analysis is that it is sufficient to consider the chosen shock alone: it is not necessary to incorporate climate change as a complex phenomenon. The model basically examines the impact of the event on the economy – through the identified channels – and then on the balance sheets of individual banks in the shorter period considered. In the case of a long-term analysis, however, we can no longer ignore the many different channels of and interactions between the processes that can be attributed to climate change. At this point, we already need pathways that, looking ahead, describe the changes in certain key variables (such as GHG emissions, temperature, precipitation, energy consumption, policy and social indicators). Incorporating expectations related to the processes can also be an important requirement. Producing or purchasing the scenarios from scenario providers and their use requires significant expertise and resources.

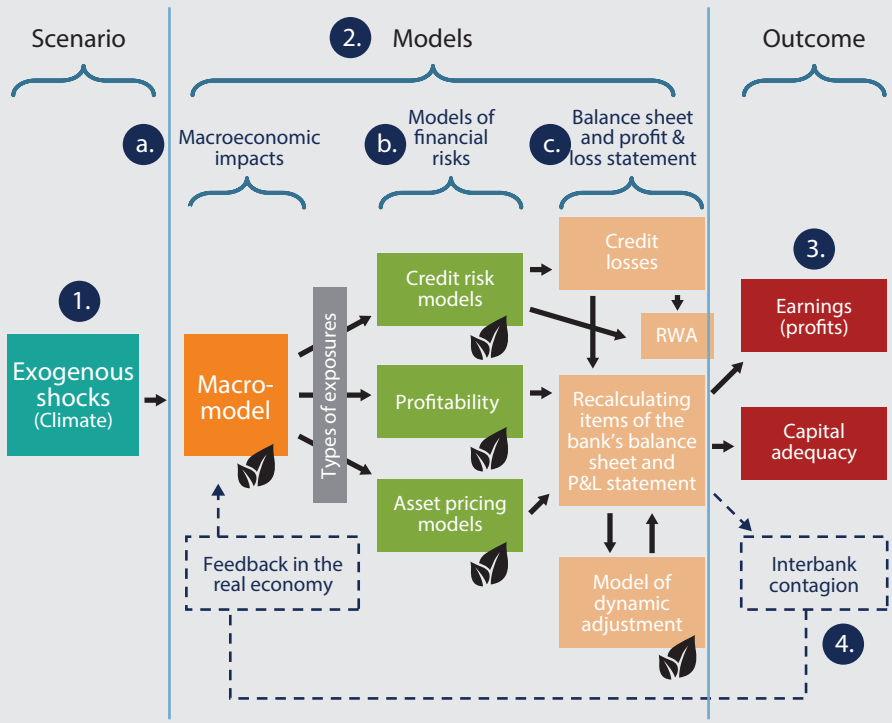
Figure 2
Shorter- and longer-term climate stress tests



The general structure of bank stress tests may be relevant for both time horizons. This structure is shown in *Figure 3* based on the ECB's methodological description (*Henry – Kok 2013*) and *Borio et al.* (*2014*). The figure indicates the key elements for which climate considerations are particularly relevant. Scenarios (*1*), which contain the exogenous changes (shocks) to be examined in different variations represent the starting point of the stress test. The first step of the modelling phase (*2*) is usually the analysis of macroeconomic and macro-financial effects, which requires a macroeconomic model suitable for the purpose and focus (*2a*). The different financial risk models for selected bank exposures (*2b*) can "translate" the outcomes of the macroeconomic model to individual banking and portfolio levels. In possession of these, the key data characterising the operation of the credit institution (balance sheet and income statement items) can be forecast for certain points and sections of the time horizon in different scenarios (*2c*). Importantly, this is not a general prognosis in the classic sense, but a forecast valid in each possible scenario. The main objective is to outline the bank's profitability and, in that context, the capital position (capital adequacy) (*3*). Namely, this will show whether the credit institution is able to remain solvent under different scenarios; whether its capital adequacy will meet minimum regulatory requirements. The most advanced stress tests also capture spillover effects and feedback (*4*), but their modelling is still typically less mature in the context of credit institution stress tests (*Borio et al. 2014*). The development and operation of short-horizon climate stress tests reaching first-round impacts on capital can already be considered the best practice among Hungarian banks, relying on existing stress testing methodologies. (Nevertheless, long-term climate stress tests are a much greater challenge even on the international scene.) The elements of the framework outlined here build closely on one another, and it is impossible to specify them without rethinking the entire modelling process. The individual components and the incorporation of climate considerations are discussed in detail in the next Chapter.[6]

[6] The aim of this essay is not to delve into the individual building blocks, but to outline the links present throughout the stress test, the role of the components, the key issues, and aspects arising from the particularities of climate change.

Figure 3
Structure of bank stress tests and incorporating climate risks



Note: Letter icons indicate climate-specific changes and the need to consider related aspects.
Source: Plotted based on Henry – Kok (2013) and Borio et al. (2014)

3. Building blocks of climate stress tests: shocks and risk models

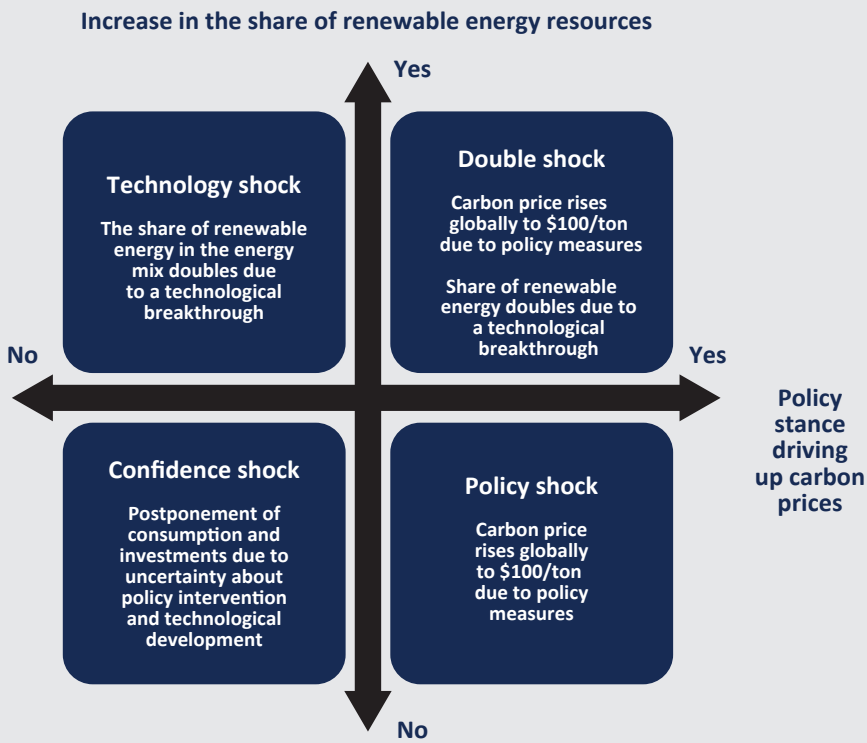
3.1. Shocks (scenarios)

The stress test becomes a climate stress test because the underlying scenarios – variations in shifts in the economy – are related to climate change. Due to their purpose, stress tests primarily examine adverse shocks, but this shall not preclude positive effects emerging in some sectors or over time in the economy as a whole. The chosen shocks must be significant in size but also plausible (*Quagliariello 2009*). Therefore, scenarios need to be defined in a way that their occurrence is realistically conceivable. If we perform an analysis for a specific, shorter-term shock (*Figure 2*), the climate protection strategies, emission reduction commitments and action plans of each government are available as guidance for identifying the

environmental and economic policy interventions expected in the near future. In Hungary, such a document is currently the afore-mentioned *NECP* (*2020*), which mainly envisages investments, subsidies, tax and regulatory changes related to energy efficiency and zero-emission technologies. Technology shocks can be derived primarily from changes in the specific costs of decarbonisation solutions (such as renewables), which affect their spread. These shocks are *disruptive* in terms of their immediate impact; thus, they radically transform the energy production that drives the economy and the positions of many market players (cf. *Di Silvestre 2018*).

As an example of shorter-term scenarios, it is worth noting that the five-year stress test of the Dutch central bank (*Vermeulen et al. 2018*) combines cases of an economic policy and a technological change, thus forming four scenarios (*Figure 4*).

Figure 4
Examples of climate risk scenarios in shorter-term stress test



Source: Plotted based on Vermeulen et al. (2018:18)

Economic policy intervention means the introduction of stringent measures that result in increasing GHG-emission costs (for example, the market price of traded carbon allowances affecting global emissions rises to 100 USD/ton). And the technological change is the breakthrough of carbon-neutral solutions with minimal emissions (renewable energy sources). In the case of a "double shock" (upper right case), both the quota price and the rate of renewables rise. This is undoubtedly the most favourable scenario for stopping climate change, however, it predicts a significant economic shock. The two shocks can also be examined separately (upper left and lower right cases). Finally, the lack of environmental policy measures and technological breakthrough represent the least promising scenario in terms of global warming (bottom left corner). The authors call this a "confidence shock". The loss of confidence of economic actors is due to failure to take the actions necessary to stop climate change. This is because huge uncertainty is created by the fact that a higher chance of a future climate disaster also involves a higher probability of a disorderly transition (i.e. late and hasty intervention). This results in the postponement of investments and consumption and in an economic downturn, even in the shorter horizon.

In addition to the scenarios, a *baseline* scenario is always needed as a benchmark, which provides a forecast valid in the absence of shocks. This can rely on official forecasts from international or national organisations or on expectations in accordance with the bank's own models. However, as the "confidence shock" of the Dutch example suggests, there is limited room for using the business-as-usual baseline when considering climate change. This is especially true for longer-term analyses. Namely, according to scientific consensus, global warming is a process on Earth still under way that we cannot ignore in the absence of appropriate measures. Thus the baseline scenario is actually provided by the unfolding of adverse climatic-weather processes, or if you prefer, the + 4°C temperature rise by 2090 shown in *Figure 1*.

This approach is also reflected in long-term climate stress testing efforts. Among the high-level scenarios of NGFS[7] (an initiative bringing together the world's leading central banks and supervisory authorities), a scenario corresponding to an uncontrolled climate catastrophe appears (*Figure 5*; "too little, too late"). This set of four high-level scenarios provides a good starting point for long-term analysis, as it addresses the unfolding of physical and transition risks together, in conjunction with one another. In the case of "too little, too late", panic-like, delayed measures cause further economic shocks, while they are no longer able to prevent adverse physical effects. *Hyne et al.* (*2019*) suggest that this scenario deserves the most attention, as the primary purpose of stress testing is to assess the realistically worst-case scenario. The European Systemic Risk Board (ESRB) also points out that the

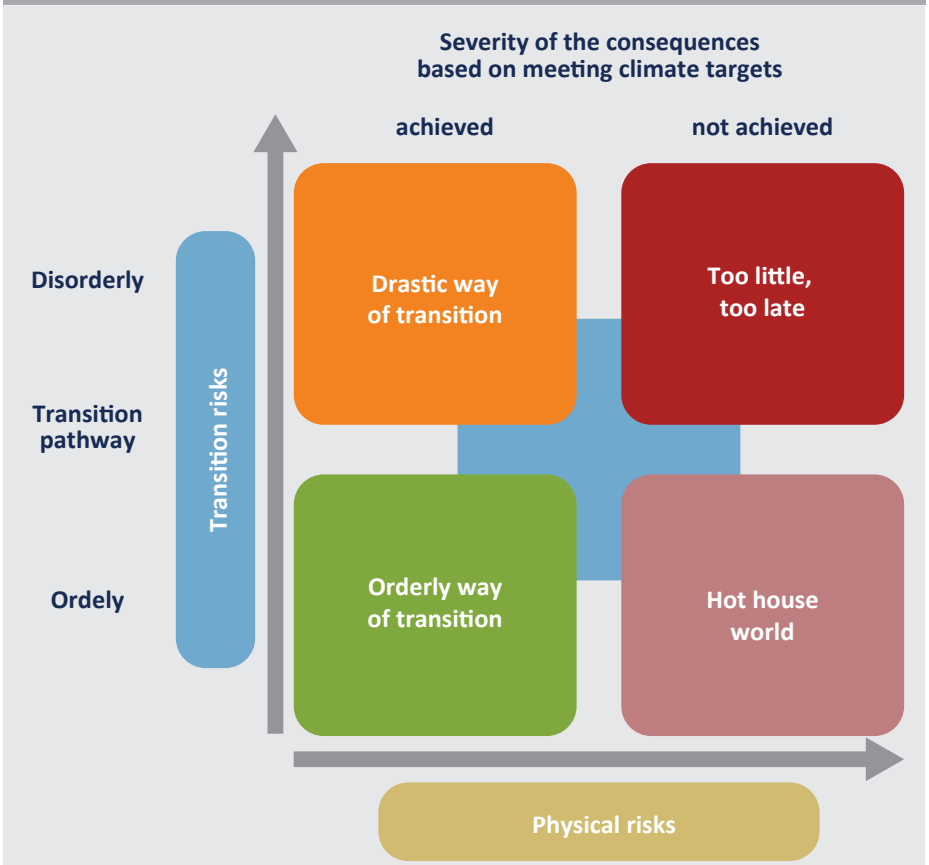
[7] Network for Greening the Financial System

occurrence of this scenario will, over time and as emissions continue to rise, become increasingly important from a financial systemic risk perspective too (*ESRB 2016*). The other three scenarios on *Figure 5* contain less drastic outcomes compared to the hasty, missed adaptation, although these also include the "greenhouse Earth". This is just as destructive from an environmental point of view (as harmful warming still occurs), "only" the economy is not hit by disruptive measures. Namely, at this point, the international community will be permanently stuck at the level of current commitments, the world will not deviate significantly from the fossil mode of operation; thus climate change will ultimately unfold. This scenario typically reflects deterrence from making sacrifices, and as a consequence, no further ambitious actions will be taken. Currently, there are several signs that we are moving on this trajectory: emission reduction commitments are being made and actions taken worldwide, but these are not considered by many to be sufficient to stop severe warming.[8] On the contrary, scenarios that meet climate targets (i.e. a drastic and orderly transition) are more favourable, although there is a difference here too: a drastic (successful, but abrupt) transition envisages a serious economic shock.

The two types of scenarios (short-term and long-term) illustrated on *Figures 4* and *5* are filled with content by the stress testing institution, taking into account its own operating environment, business strategy and exposures. However, climate change is an unknown "terrain" for credit institutions; it falls outside of the scope of regularly analysed economic and financial risks, therefore (external) expert support may be needed even for the shorter time horizon. Today, many scientific institutes, organisations and consulting firms (hereinafter collectively referred to as: scenario providers) offer solutions. In addition, the fact that central banks, supervisory authorities and international organisations are also striving to create uniform, accessible sets of scenarios (e.g. *2° Investing Initiative 2018*; *BoE 2019*) is a positive development. In the future, these uniform scenarios handed over to banks may be the basis for climate stress tests. But even then, it is important that credit institutions make their own assessments regarding the range of physical and transition risks that are most relevant to them.

[8] The future may well hold rapid and dramatic measures, and with that we can even pass into the "too little, too late" scenario. At the same time, recent international summits have raised doubts as to whether further large-scale, joint international action would be taken.

Figure 5
Baseline scenarios for climate change and human intervention in long-term stress tests



Source: Plotted based on NGFS (2019:21)

A crucial aspect in developing scenarios is that the macroeconomic model available should be able to integrate the information (*Figure 3 2a*). More generally, the scenarios and the macroeconomic model should be chosen together, both interlinked. (As already mentioned, all elements of the process are closely linked.) In the relationship between scenarios and the macroeconomic model, the provision of transmission channels is the crucial point, which can even become the biggest challenge of the entire climate stress testing. The credit institution must determine the sections of the economy (actors, sectors, etc.) primarily affected by the physical and/or transition events to be analysed and the way this initial effect manifests. In a shorter-term analysis, where the focus is on the course of one or a few specific shocks, this information is somewhat easier to specify and translate into the language of macroeconomics (modelling).

However, even in such cases, the connection with the macroeconomic model is made difficult by the fact that data on identical historical events and situations are typically not available to determine the magnitude of the initial effects. This problem can be partially resolved by identifying similar shocks, using data and assumptions available in literature, and by means of expert estimation. (However, the applicability of historical data is limited as the future magnitude of impacts naturally may differ significantly from experience thus far.) Scenario providers' scenarios include related assumptions, and the provider frequently even carries out the macroeconomic modelling. When it comes to the long-term complex analysis of climate and socio-economic pathways, it is even more necessary to create a close connection and a unified framework for scenario building and macroeconomic modelling.

3.2. Macroeconomic model

Thus although macroeconomic effects often appear as part of scenarios, it is worth separately addressing the models that produce them (*Figure 3 2a*). Based on their purpose, *Blanchard* (*2018*) distinguishes five general types of macroeconomic model: basic theoretical models, dynamic stochastic general equilibrium (DSGE) models, policy models, "toy models" (tools of the simplest macroeconomic illustration), and forecasting XXXX models. Of all these, policy and forecasting models are the closest to the objectives of climate stress tests. Policy models are designed to analyse specific economic policy problems, the dynamic impact measurement of the intervention alternatives, their main goal being to explore the patterns.[9] Forecasting models have obviously one goal in mind: to produce the best forecasts. These are primarily statistical-econometric models and their main questions are related to fitting. There is of course no sharp boundary between the individual model types, but grouping helps to determine the tools needed for climate stress testing, thus in particular, to assess the suitability of credit institutions' internal macroeconomic models. In climate stress tests, especially in the longer term, a combination of the policy-type and forecasting model approach may provide the most useful results.

One of the model families frequently used by scenario providers is called *integrated assessment models* (IAM). These are not explicitly macroeconomic models, but capture the correlations between energy consumption, climate/environment, demography, and economic activity (*IPCC 2013*; *Farmer et al. 2015*; *Hare et al. 2018*). The integrating economic elements are usually based on the principles of general equilibrium and market efficiency. This is because IAM models combine simplified models of the considered spheres and, first and foremost, seek to create

[9] These models may also be DSGE-based, "but their theoretical structure must by necessity be looser than for DSGE," thus "leading to much more complex overall dynamics than a tight theoretical model can hope to capture" (*Blanchard 2018:53*).

interactions. Of the three main components (energy, climate, socio-economic system) they rather break only the first down into more detail, global and regional energy systems. The overall goal is to forecast the consequences and outcomes of different climate policies. However, *Farmer et al.* (*2015*) point out that IAM models can be subject to a number of criticisms: they do not adequately address the significant uncertainty of climate change; they use a high degree of simplification (representative household, company); their functions determining environmental damage are highly stylised; and they are less able to capture technological progress in a complex way. These criticisms mainly concern the economic content of IAMs, which also influences the reality of the energy consumption, emission and environmental trajectories provided by the models. Therefore, and due to the narrow range of macroeconomic outputs, IAM models can mostly play an intermediate, "intermediary" role between climate scenarios and the main macroeconomic model, for example in producing some input trajectories needed for the latter.

In the economic component of IAMs and also in other climate modelling applications, the so-called *computable general equilibrium models* (CGE) appear. These, as mentioned above, start from micro-level optimising behaviour. They are typically static, aimed at determining the equilibrium price and quantity, and thus allow for comparative static analyses (aimed at comparing equilibrium situations).[10] Assumptions of CGE models concerning the financial system are usually unrealistic (*Pollitt – Mercure 2018*). The cited authors point out that in the traditional approach of the CGE, climate protection policies almost always have negative economic consequences (GDP decline). This is because green investments have a crowding-out effect on other sectors of the economy.

Pollitt and Mercure (*2018*) emphasise the advantages of *non-equilibrium, empirical* (*macro-econometric*) *models* over CGE. These models have long been established tools for economic forecasting and combine both theoretical and data-driven correlations.[11] They do not assume the optimising behaviour and perfect rationality of economic actors, instead they use behavioural equations "read" from the data by means of econometric tools. The long-term equilibrium of the economy is also not a baseline. Macro-econometric models focusing on climate change have also been created in recent decades. One of them is the E3ME model, in whose name the 3E refers to the relationship between the economy, energy systems and the

[10] CGE models have a number of features in common with DSGE models treated as a distinct category by *Blanchard (2018)*. The latter are dynamic (describe the economic fluctuations), but typically model the economy at a much more aggregate level compared to CGE models (See: *Computable General Equilibrium Modelling: Introduction*. Chief Economist Directorate, Scottish Government, published on 6 January 2016. https://www.gov.scot/publications/cge-modelling-introduction/. Downloaded: 21 April 2020).

[11] For the theoretical correlations the post-Keynesian background is typical, the main elements of which being the theory of efficient demand and endogenous money, the privileged role of uncertainty and expectations, and the consideration of income distribution and institutions (*Horváth 2003*).

environment. The non-equilibrium nature of the model (potential for unused capacity) ensures that the steps of a climate-neutral transition can even entail positive GDP developments (*Cambridge Econometrics 2019*). The disadvantage of macro-econometric models similar to E3ME may be that they are extremely data-intensive and require reliable and long time series for a number of economic and environmental variables.[12]

For the next phase of the stress test – bank risk calculations – two essential features of the macroeconomic model need to be highlighted. On the one hand, it is important for the model to produce trajectories of as many macro variables as possible. The most basic, of course, are GDP and its components (consumption, investment, net exports), along with indicators for companies and households separately (disposable income of households, activity rate, unemployment, etc.), and inflation. At the same time, not only macroeconomic but also macro-financial variables are needed, such as different interest rates (points on yield curves) and exchange rates. In addition, it would be favourable for the model to provide information on financial stocks and flows too: in particular, financial savings, borrowing or net financial assets of households, corporate borrowing and/or the various consolidated ratios of the banking system. This also indicates the importance of the financial intermediary system appearing in the model under sufficiently realistic assumptions (e.g. endogenous money creation). However, it is most likely that the available solutions will only produce financial variables on a narrower scale. (Exceptions to this may be credit institutions' own internal macro-models.)

On the other hand, the next phases of stress testing require that macro-level outputs also be available in a proper industrial breakdown (*Allen et al. 2020*). Industries shall mean the sectors of economic activity. Namely, the industrial pathways carry important information about the vulnerabilities and risks of the financed companies in certain scenarios. Climate change-related shocks can manifest in different ways and to different extents, for example in vehicle manufacturing, mining or accounting and advisory services. However, we cannot expect a specifically detailed breakdown from these models, as their primary purpose is not to perform industrial analysis. For this reason, where applicable, it may be useful to use several industry-specific models (in a complementary manner). Additional climate-related delimitations can be introduced in the next phase of stress testing.

3.3. Financial risk models

In possession of the information on macroeconomic and industrial effects, the analysis of the specific situation of a bank can begin (components *2b* and *2c* of *Figure 3*). To do this, we must first decide which bank exposures to include in the stress test. Ideally, the test covers the entire operation of the bank and all its

[12] There are certainly many other modelling approaches, which are not covered in the essay.

exposures, as this is the only way to quantify the expected impacts on profitability and own funds fully and consistently. However, if necessary and depending on the available toolbox, a partial analysis is also conceivable: in the case of domestic commercial banks, highlighting the credit exposures (banking book) may be considered above all else. Then, component *2b* can rely on a narrower set of tools. The essay reviews issues of a wide range of exposures.

Mapping the entirety of banking operations and all the exposures requires a number of risk models, correlations and assumptions. These are already available to credit institutions for "normal" stress tests, at least for their normal time horizon. The toolbox for measuring and analysing credit risk, market risk, operational risks and profitability (and to a lesser extent liquidity risk) should be considered here. Applying these tools in the context of climate stress tests, however, raises a number of issues and amendment requirements.[13]

Credit risk is the risk of the non- or non-contractual performance of bank debtors. Credit risk models are aimed at assessing expected credit loss (ECL). This requires the determination of clients' probability of default (PD), exposure at default (EAD) and loss given default (LGD), the product of which gives the ECL. The calculation approach differs significantly for mass standard loans (retail, small business), and larger, individually considered loans (large corporate, project). Regardless of type, however, climate stress testing will definitely pose two significant challenges in modelling the components of ECL. One is the direct representation of vulnerability to climate change in the PD, and the other is the climate-based revaluation of collateral in LGD calculations.

The PD calculation is based on the collection of factors statistically related to non-payment (characteristics of the debtor and the transaction). As already mentioned, the PD of individual corporate clients is significantly affected from a climate perspective by their industry. Thus, it is advisable to include the macro variables broken down by industries into the PD factors. With granular data, it is also worth making a distinction between clients within industries based on their vulnerability. Thus in the energy sector for example, *ceteris paribus* there may be a higher PD for fossil fuel power plants, in line with the given scenario, and a lower one for solar power plants.[14] The approach developed by the United Nations

[13] To assess liquidity, credit institutions usually perform dedicated liquidity stress tests. Many aspects of liquidity (e.g. daily liquidity, foreign exchange liquidity) are not the focus of stress tests focusing on capital adequacy, and this is especially true of complex climate stress tests to assess long-term effects. Liquidity risk is therefore not covered in this essay. Banking risks and their fundamental conceptual elements are further defined based on *Walter* (*2016*).

[14] The need for differentiation arises, *inter alia*, because the industrial breakdowns available for macro-modelling are unlikely to carry sufficient climate-related information. Namely, the most commonly used classifications (NACE, in Hungary: TEÁOR) were not developed from this perspective or for this purpose (*Battiston et al. 2017*). In addition, even for climate classifications, companies with a mixed profile/strategy (such as a company producing both fossil fuel and electric vehicles) would pose a problem.

Environment Programme and 16 contributing large banks (*UNEPFI 2018b*) is aimed exactly at this: it ranks actors in each industry according to the key risk factors in the scenarios (from low to high risk) and then diverts companies' PDs based on the classification. The basis for the vulnerability classification can be, for example, carbon intensity characteristic of industry subgroups (amount of CO_2 incorporated per unit of output), and/or information derived from individual large enterprise strategies. There is certainly little or no historical data available to fit macro variables broken down by industry into the PD model (significance, coefficients, etc.) and to determine the PD deviation within the industry. Therefore the calibration may rely primarily on literature/expert estimates and internal information available for some large clients. In addition to identifying the initial macro channels, this represents another serious challenge to climate stress testing.

In the retail sector, the most critical "targets" of climate change and the carbon-neutral transition are real estate, which, when used as collateral, mitigate the expected credit losses of banks. Properties with poor energy efficiency, with only fossil heating, or those more exposed to extreme weather can lose significant value in some scenarios for climate change. However, these hidden risks are currently barely reflected in collateral valuation practices. Real estate or other fixed asset collateral behind corporate loans can also face a steep revaluation (drop in value), as their use can rapidly or prematurely become impossible due to their high GHG emissions and carbon dependence. A huge part of literature deals with these so-called "*stranded assets*", which include fossil fuel mines and stocks, the plant units using them, and large production machines (*Caldecott et al. 2014; Weyzig et al. 2014*). Issues of collateral valuation affect LGD calculations to a great extent.

"Stranded assets" are also present in the securities markets, so they cannot be ignored in terms of securities collateral and exposures in the banks' trading books. Market risk includes the revaluation risk (exchange rate movement) of just these positions, including not only securities but also foreign currencies and commodities. According to the frequently cited "carbon bubble" problem, the market has typically not yet priced in the risks of climate change and the associated risks of socio-economic transition for these instruments. Thus many of the assets involved are currently overvalued. However, upon investor recognition, the bubble may burst (*Weyzig et al. 2014; Griffin et al. 2015*). Market risk models are most often based on forecast cash flows, therefore, changes related to climate change may primarily require a revision of *cash flow forecasts* (see, for example, *Hayne et al. 2019*). From among the wide range of operational risks, it is worth highlighting the legal and reputational risks – especially the so-called liability risk, which may pass onto the credit institution mainly due to the financing of polluting economic activities in breach of environmental standards. However, the possibility of quantifying such risks is limited.

According to *Figure 3*, in addition to the individual key risk models, it is also necessary to take stock of bank profitability, which the specific projection of the stocks and flows of banking operations can rely on (*2c*). Such correlations should be available, at least in the form of assumptions and strategic targets, for the development of bank pricing (interest margins, fees and commissions), trading profit, operating cost ratio, etc. In these cases, climate change as a framework prevails in two main ways. On the one hand, a significant part is based on some outcome pathways of the macroeconomic model that processes climate scenarios (e.g. yield curves). On the other hand, a credit institution may modify "normal" assumptions (e.g. project a higher cost ratio due to the drastic transition as a result of the increasing resource requirements for managing bad loans).

3.4. Bank reports (financial statements)

With the full set of tools, the credit institution's various financial items are systematically converted in each scenario to the individual points of time/periods of the analysis horizon (2c). This requires reports and statements corresponding to the *cut-off* date (balance sheet, income statement, analytics, etc.). In the case of credit exposures, credit losses (CL) are calculated using the PD and LGD models developed in the previous step. The revaluation of items carrying market risk also contributes to quantifying the impacts on profitability and determining future exposure values. By applying the appropriate weights, the development of the bank's *risk-weighted assets* (RWA) can be forecast, which is also a condition for the provision of capital adequacy (capital adequacy ratio) (*3*).

In all this, the crucial issue is the assumption concerning a change in the balance sheet total. In the shorter term, it may be acceptable to consider the balance sheet total unchanged (the so-called *gross static balance sheet assumption*).[15] However, this leads to less realistic results as it does not allow for adaptation to the scenario (*Resti 2018*). Climate stress tests, especially over a longer time horizon, should contain certain dynamic elements, which allow for the bank to assess and select clients based on their vulnerabilities and climate actions. It can be a kind of simple sensitivity analysis that reveals the consequences of giving priority to clients with a better environmental performance under a given scenario.

3.5. Capital adequacy as an outcome and consideration of spill-over effects

As already stated, the purpose of climate stress tests is to assess the development of credit institution profitability and, in this context, capital adequacy in each scenario (*Figure 3, 3*). The most advanced stress tests may even be able to assess spillovers and "contagions" (*4*) in the banking system. (A possible modelling approach is

[15] Accordingly, bank assets and liabilities that mature within the time horizon of the stress test are replaced at maturity by items of the same type, currency, maturity and credit quality. As a result, not only the size but also the composition of the balance sheet total remains unchanged (*Resti 2018*).

presented by *Haldane – May 2011*). The second-round impacts may also include real economic feedback: if a climate-neutral transition brings about an economic downturn and a substantial increase in non-performing loans in the shorter term, banks may stop lending as a response (in an overall sense or to certain industries).

4. Conclusions

The essay reviewed the basic issues, possible structure, and main challenges of credit institution climate stress tests with the aim of outlining a comprehensive framework for performing bank climate stress tests in Hungary for stakeholders (market players, macro- and micro-prudential policy).

Climate change can entail significant temperature rises and thus environmental damage (physical risk). To prevent this, humanity must significantly reduce its GHG emissions and put the economy on a carbon-neutral path through technological change and economic policy intervention (transition risk) to reach the Paris climate target of less than +2°C. These processes primarily affect credit institutions through their clients, i.e. the financed actors. Identifying vulnerabilities is important for prudent operation and compliance with related recommendations, but it also poses a major challenge for banks. The level of uncertainty is much higher than "normal", mainly due to the lack of historical data as well as the lengthy time horizon and many interactions of the unfolding climate change. There are basically two options for risk measurement: identifying one or a few specific shocks and examining the direct, shorter-term (3–5 years) adaptation of the economy, or a long-term analysis of weather events and the complex dynamics of the decarbonisation process. The former is closer to "normal" bank stress tests and easier to manage with its existing toolbox. The latter, which can also provide the bank with a much more comprehensive picture for strategy-making, holds many more challenges that are still subject to intense thinking among the world's financial institutions.

The general structure of stress tests can be relevant over both time horizons. The analysis starts from scenarios of exogenous shocks attributable to climate change. Defining scenarios and identifying mechanisms of action are probably the biggest task of climate stress testing. The shocks and the pathways of key factors must be given in a way to enable the macroeconomic model to incorporate and process them. The description of real economic and macro-financial impacts therefore requires that the scenarios and the macro-model be selected together, both interlinked. To this end, especially in the case of long-term complex analysis, involving external experts may be unavoidable. In analytical practice, there are several signs that statistical-econometric models relying on empirical behavioural equations are most suitable for climate stress tests. Such models should include the interlinkages and interactions of the atmosphere and the environment,

energy consumption and the economy. Another important requirement for the macroeconomic model is the industrial breakdown and the realistic management of the financial system, the production of some systemic financial variables. The outcome pathways of the macroeconomic model should be tailored to the needs of the risk models underlying the individual banking calculations. Addressing several specific issues of climate shocks and "fine-tuning" the effects is only possible by reconsidering the existing risk models, correlations and assumptions. This phase represents the other key challenge for climate stress testing. Questions need to be answered on how actors within a sector differ regarding their PD emission and strategies, or how to take into account the risks inherent in pricing "stranded assets". In possession of the appropriate models, correlations and assumptions, the main financial items of the credit institution are systematically re-calculated at different points/sections of the time horizon in each scenario. In this phase, the main issue is how to relax the gross static balance sheet assumption. By overcoming all of these challenges, the credit institution arrives at the main outcome, the expected pathways of profitability and capital adequacy under each scenario. The analysis can be further completed by mapping the impacts on the financial system and macroeconomic spillovers arising from the bank's position (feedback). The overall conclusion of the process is that the building blocks are closely related and can only be "optimised" in the light of the analysis as a whole.

Solving any of the challenges means, with a little exaggeration, reviewing a library's worth of literature and requires many working hours. However, the preliminary review and establishment of the framework simplifies the work of credit institutions markedly, serves as a compass, and ultimately, is more important than the details. Simpler assumptions can also be explicitly useful if they are clear and their impact on the results can be traced. Carrying out climate stress tests as soon as possible is in the interest of banks, central banks and supervisory authorities, and even a wide range of economic actors, not only to address vulnerabilities but also to seize the opportunities offered by decarbonisation.

References

2° Investing Initiative (2018): *2° Scenario Analysis.* Background Information on the "Paris Agreement Capital Transition Assessment" (PACTA) Scenario Analysis Tool. https://www.transitionmonitor.com/wp-content/uploads/2018/08/Scenario-Analysis-Background-Information.pdf. Downloaded: 2 April 2020.

Allen, T. – Dees, S. – Boissinot, J. – Caicedo Graciano, C.M. – Chouard, V. – Clerc, L. – de Gaye, A. – Devulder, A. – Diot, S. – Lisack, N. – Pegoraro, F. – Rabaté, M. – Svartzman, R. – Vernet, L. (2020): *Climate-Related Scenarios for Financial Stability Assessment: an Application to France*. Working Paper, No. 774, Banque de France, July. https://doi.org/10.2139/ssrn.3653131

Battiston, S. – Mandel, A. – Monasterolo, I. – Schütze, F. – Visentin, G. (2017): *A Climate Stress-Test of the Financial System.* Nature Climate Change, 7: 283–288. https://doi.org/10.1038/nclimate3255

Battiston, S. – Monasterolo, I. (2019): *A Climate Risk Assessment of Sovereign Bonds' Portfolio.* Paper, WU Vienna University of Economics and Business. https://epub.wu.ac.at/7261/. Downloaded: 19 March 2020.

BlackRock (2015): *The Price of Climate Change. Global Warming's Impact on Portfolios*. https://www.blackrock.com/corporate/literature/whitepaper/bii-pricing-climate-risk-international.pdf. Downloaded: 7 January 2019.

Blanchard, O. (2018): *On the Future of Macroeconomic Models*. Oxford Review of Economic Policy, 34(1–2): 43–54. https://doi.org/10.1093/oxrep/grx045

BoE (2018): *Transition in Thinking: The Impact of Climate Change on the UK Banking Sector.* Prudential Regulation Authority, Bank of England, September. https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/report/transition-in-thinking-the-impact-of-climate-change-on-the-uk-banking-sector.pdf. Downloaded: 20 November 2018.

BoE (2019): *The 2021 Biennial Exploratory Scenario on the Financial Risks from Climate Change*. Discussion Paper, Bank of England, December. https://www.bankofengland.co.uk/paper/2019/biennial-exploratory-scenario-climate-change-discussion-paper. Downloaded: 8 January 2020.

Borio, C. – Drehmann, M. – Tsatsaronis, K. (2014): *Stress-Testing Macro Stress Testing: Does it Live up to Expectations?* Journal of Financial Stability, 12(June): 3–15. https://doi.org/10.1016/j.jfs.2013.06.001

Burke, M. – Hsiang, S.M. – Miguel, E. (2015): *Global Non-Linear Effect of Temperature on Economic Production*. Nature 527: 235–239. https://doi.org/10.1038/nature15725

Caldecott, B. – Tilbury, J. – Carey, C. (2014): *Stranded Assets and Scenarios.* Discussion Paper, Smith School of Enterprise and the Environment, University of Oxford.

Cambridge Econometrics (2019): *E3ME Technical Manual v6.1*. https://www.e3me.com/wp-content/uploads/2019/09/E3ME-Technical-Manual-v6.1-onlineSML.pdf. Downloaded: 31 March 2020.

Di Silvestre, M. L. – Favuzza, S. – Sanseverino, E. R. – Zizzo, G. (2018): *How Decarbonization, Digitalization and Decentralization Are Changing Key Power Infrastructures*. Renewable and Sustainable Energy Reviews, 93(October): 483–498. https://doi.org/10.1016/j.rser.2018.05.068

ESRB (2016): *Too Late, Too Sudden: Transition to a Low-Carbon Economy and Systemic Risk*. Reports of the Advisory Scientific Committee, No. 6, European Systemic Risk Board. https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_6_1602.pdf. Downloaded: 15 January 2019.

Farmer, J.D. – Hepburn, C. – Mealy, P. – Teytelboym, A. (2015): *A Third Wave in the Economics of Climate Change*. Environmental and Resource Economics, 62(2): 329–357. https://doi.org/10.1007/s10640-015-9965-2

Feyen, E. – Utz, R. – Huertas, I. Z. – Bogdan, O. – Moon, J. (2020): *Macro-Financial Aspects of Climate Change*. *Policy Research Working Paper*, No. 9109, World Bank Group. https://doi.org/10.1596/1813-9450-9109

FSB–TCFD (2017): *Recommendations of the Task Force on Climate-Related Financial Disclosures. Final Report.* Financial Stability Board – Task Force of Climate-Related Financial Disclosures, June. https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf. Downloaded: 14 April 2020.

Gallic, E. – Vermandel, G. (2019): *Weather Shocks.* HAL Archive Ouverte en Sciences de l'Homme et de la Société, 13 May. https://halshs.archives-ouvertes.fr/halshs-02127846. Downloaded: 18 March 2020.

Griffin, P. A. – Myers Jaffe, A. – Lont, D.H. – Dominguez-Faus, R. (2015): *Science and the Stock Market: Investors' Recognition of Unburnable Carbon*. Energy Economics, 52: 1–12. https://doi.org/10.1016/j.eneco.2015.08.028

Haldane, A.G. – May, R.M. (2011): *Systemic Risk in Banking Ecosystems*. Nature, 469(January): 351–353. https://doi.org/10.1038/nature09659

Harari, Y.N. (2015): *Sapiens. Az emberiség rövid története* (*A Brief History of Humankind*). Animus Kiadó, Budapest.

Hare, B. – Brecha, R. – Schaeffer, M. (2018): *Integrated Assessment Models: What Are They and How They Arrive at Their Conclusions?* Climate Analytics, October. https://climateanalytics.org/media/climate_analytics_iams_briefing_oct2018.pdf. Downloaded: 20 April 2020.

Hayne, M. – Ralite, S. – Thomä, J. – Koopman, D. (2019): *Factoring Transition Risks into Regulatory Stress-Tests: The Case for a Standardized Framework for Climate Stress Testing and Measuring Impact Tolerance to Late & Sudden Economic Decarbonization*. 2° Investing Initiative. EBA 8th Policy Research Workshop, European Banking Authority, 27–28 November. https://doi.org/10.35944/jofrp.2019.8.1.013

Henry, J. – Kok, C. (ed.) (2013): *A Macro Stress Testing Framework for Assessing Systemic Risks in the Banking Sector*. *ECB Occasional Paper Series*, No. 152, European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp152.pdf

Horváth, L. (2003): *A post-keynesi szemlélet és elosztáselméleti alkalmazása* (*Application of the post-Keynesian approach and distribution theory*). PhD dissertation, Department of Macroeconomics, Budapest University of Economic Sciences and Public Administration.

IPCC (2013): *Climate Change 2013. The Physical Science Basis.* Intergovernmental Panel on Climate Change, Working Group 1, Contribution to the Fifth Assessment Report of the IPCC. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

ITM (2020): *Nemzeti Energia- és Klímaterv* (*National Energy and Climate Plan*). Innovációs és Technológiai Minisztérium (Ministry of Innovation and Technology), Hungary. https://ec.europa.eu/energy/sites/ener/files/documents/hu_final_necp_main_hu.pdf. Downloaded: 14 April 2020.

Marshall, G. (2014*): Don't Even Think About It. Why Our Brains Are Wired to Ignore Climate Change.* Bloomsbury USA, New York.

MNB (2019): *Green Finance in Hungary.* Consultation document, Magyar Nemzeti Bank, 3 July. https://www.mnb.hu/letoltes/green-finance-in-hungary-consultation-paper.pdf. Downloaded: 14 April 2020.

NGFS (2019): *A Call for Action. Climate Change as a Source of Financial Risk.* First Comprehensive Report, Central Banks and Supervisors Network for Greening the Financial System, April. https://www.ngfs.net/sites/default/files/medias/documents/ngfs_first_comprehensive_report_-_17042019_0.pdf. Downloaded: 16 April 2020.

Pollitt, H. – Mercure, J.-F. (2018): *The Role of Money and the Financial Sector in Energy-Economy Models Used for Assessing Climate and Energy Policy*. Climate Policy, 18(2): 184–197. https://doi.org/10.1080/14693062.2016.1277685

Quagliariello, M. (ed.) (2009): *Stress-Testing the Banking System. Methodologies and Applications.* Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511635618

Resti, A. (2018): *How Demanding and Consistent Is the 2018 Stress Test Design in Comparison to Previous Exercises?* Banking Union Scrutiny, In-Depth Analysis Requested by the ECON Committee, European Parliament, June. https://www.europarl.europa.eu/RegData/etudes/IDAN/2018/614511/IPOL_IDA(2018)614511_EN.pdf. Downloaded: 23 April 2020.

Rudebusch, G.D. (2019): *Climate Change and the Federal Reserve*. FRBSF Economic Letter, 2019–9, Federal Reserve Bank of San Francisco. https://www.frbsf.org/economic-research/files/el2019-09.pdf. Downloaded: 2 April 2020.

Staden, C. van (2020): *COVID-19 and the Crisis of National Development*. Nature Human Behaviour, 4: 443–444. https://doi.org/10.1038/s41562-020-0852-7

Stamate, A. – Tatarici, L. (2019): *Climate Risks. Implications for the Financial Sector.* National Bank of Romania, 13th Edition of the Seminar on Financial Stability Issues, Bucharest, 13 September. https://www.bnr.ro/DocumentInformation.aspx?idDocument=32455&directLink=1. Downloaded: 6 January 2020.

Taleb, N.N. (2007): *The Black Swan: The Impact of the Highly Improbable.* Penguin Random House, New York.

UN (2015): *Paris Agreement*. United Nations Framework Convention on Climate Change, 12 December. https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf. Downloaded: 2 April 2020.

UNEPFI (2018a): *Navigating a New Climate*. United Nations Environment – Financial Initiative & Acclimatise Group Ltd. https://www.unepfi.org/publications/banking-publications/navigating-a-new-climate-assessing-credit-risk-and-opportunity-in-a-changing-climate/. Downloaded: 8 August 2018.

UNEPFI (2018b): *Extending our Horizons.* United Nations Environment – Financial Initiative & Oliver Wyman. https://www.unepfi.org/wordpress/wp-content/uploads/2018/04/EXTENDING-OUR-HORIZONS.pdf. Downloaded: 8 August 2018.

Vermeulen, R. – Schets, E. – Lohuis, M. – Kölbl, B. – Jansen, D.-J. – Heeringa, W. (2018): *An Energy Transition Risk Stress Test for the Financial System of the Netherlands*. *Occasional Studies*, Vol. 16/7, De Nederlandsche Bank.

Walter, Gy. (2016): *Kereskedelmi banki ismeretek* (*Commercial banking knowledge*). Alinea Kiadó, Budapest.

Weyzig, F. – Kuepper, B. – Gelder, J.W. van – Tilburg, R. van (2014): *The Price of Doing Too Little Too Late. The Impact of the Carbon Bubble on the EU Financial System*. A report prepared for the Greens/EFA Group – European Parliament. Green New Deal Series, Vol. 11, February. https://gef.eu/wp-content/uploads/2017/01/The_Price_of_Doing_Too_Little_Too_Late_.pdf. Downloaded: 3 January 2019.

Is Economic Growth a Goal, or a Means?*

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Katherine Trebeck – Jeremy Williams:
The Economics of Arrival – Ideas of a Grown-Up Economy
Bristol University Press, 2019, p. 224.
ISBN: 978-1447337263
Hungarian translation:
A megérkezés gazdaságtana – Gondolatok egy felnőtt gazdaságról
Pallas Athéné Könyvkiadó, Budapest, 2020, p. 352
ISBN: 978-615-5884-62-7

The evolution of economic growth is a central aspect of almost all serious social, public life and political questions. Most specifically, GDP growth has become an absolute indicator. But is GDP growth always a reliable indicator of social well-being, common interests, improvement to quality of life or improvement to the life or future of humanity? The book by Trebeck and Williams "The Economics of Arrival – Ideas of a Grown-Up Economy" revolves around these questions: At first sight, many might say that GDP growth cannot always grasp these values exactly, and yet this question is not quite as simple as that. Sometimes it grasps them well, and sometimes many people think there simply is no better approach. Therefore, the book also proposes some constructive alternatives, rather than just providing a critique of prevailing approaches.

Economic growth as a goal gives rise to several problems, from the overexploitation of nature to social injustice. The topic of climate change is unavoidable today, and the biggest obstacle in the fight waged against it is that it would harm GDP growth. While the developed world is living in better prosperity than ever before, and it provides people with outstanding living conditions even on a historic scale, people are not willing to relinquish even some economic growth to ensure this well-being in the long term. They would rather risk the good chance of losing everything. Similarly, it is rather intriguing that while the wealth of the developed world would be more than enough for everybody, many people still live in deep poverty even in the most developed countries of the world. These two examples alone presented

* 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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by the authors shed light on all the issues brought up by economic growth being the goal rather than the means.

Additionally, empirical studies have found that growth in financial wealth often does not lead to a better quality of life, which gives rise to further questions. The work of Nobel Prize Laureate Kahneman et al unequivocally proves that an increase in income over a certain amount (USD 75,000 in the USA in 2010) does not make people happier[2]. This raises the question of why we are still trying to grow beyond this level on the basis of income and economic wealth. The authors also ask whether it might be better to aim for as many people as possible to reach this level of income, rather than for increasing the average. How far should we go in setting economic growth as a goal when it does not even guarantee a happier life to most people, and incurs huge societal costs in other areas.

Economic growth has today become a strong narrative to the extent that it is unquestionable for many. The authors, however, rightfully warn that this often blocks any constructive dialogue. Chapters four and five of the book show the spectacular contradictions brought about by the social establishment that considers economic growth as the primary objective. If the economy is to grow further, we need to consume more. However, the goods necessary for a higher level of consumption can only be achieved with more work, which will not leave enough time for us to do whatever makes us happy. This creates a vicious circle. True, we consume more, but our lives are not necessarily any better or happier. Many estimates reveal that large parts of developed economies are engaged in producing goods without any natural demand for them. This triggers an important and long-standing philosophical question: what demands should actually be satisfied, and what demands derail the economy. Although the answer is not easy, according to Plato, the ancient philosopher, there are two types of demand, natural and unnatural. He says a natural demand can be satisfied, but an unnatural demand can never be fully satisfied. For example, if somebody is hungry, they will reach a point when they no longer desire food. On the contrary, demand for money is unnatural, as man will desire more and more money, which makes this demand insatiable. If we think about how many demands are natural and how many are unnatural in our personal life, we will get a surprising answer. Surveys show that people wish for a bigger living space, a better car and a higher salary. These are all demands that are unnatural according to Platonian philosophy, because they can never be properly satisfied. In the United States for instance, per capita income and living area have multiplied in recent decades, but society has not become happier. Conversely, hunger has not been eliminated to the same extent.

[2] Kahneman, D. – Deaton, A. (2010): *High income improves evaluation of life but not emotional well-being*. Proceedings of the National Academy of Sciences, 107(38), 16489–16493. https://doi.org/10.1073/pnas.1011492107

One strength of the book is that it not only lists the problems, but it also formulates several proposals for discussion. For instance, accomplishment may be a new goal instead of economic growth – as suggested by the book. The word homemaking is often used for this, which implies that improving our direct living conditions is a more worthy goal than overall economic growth.

To create a new social attitude, and to put economic growth in the right place, enormous changes are necessary at various levels of our society and economy. This is what the last few chapters of the book offer a specific proposal for, urging for the fastest possible changes even if they are small individual steps. The institutional, political and public life systems created should prevent problems rather than react to them. But at least they should not generate problems, as they do in our current economy. The book offers the example of the United Kingdom, where according to estimates the social cost of the impacts of "negative consumption", mainly in the area of health care, amounted to GBP 184 billion in 2015 (more than HUF 70,000 billion). This means that we are consuming many products which we do not have real demand for. This consumption, however, leads to several societal problems through obesity, dementia, diabetes or even mental diseases.

Finally, the authors break down the change path into the specific steps to be taken by different social players. However, they admit that this path is long, and it is unforeseeable when we will finally set out on the journey, if indeed we do. But the closing idea of the book may motivate all readers to take the first step on this path to change: "the future is not about expansion, but about improvement".

Motivation and Cooperation*

Pál Péter Kolozsi

Bianka Parragh (ed.):
Ösztönző állam – hatékonyabb vállalatok
(*Motivating State - More Efficient Companies*)
Akadémiai Kiadó, 2019, p. 336
ISBN: 978-963-454-547-7

What should be controlled by the market and what should we entrust to the state? What roles should mutual market relations based on interdependence play, and what should be the weight attached to a state representing the interests of the community? If any, these are certainly fundamental questions of economics. Economists keep revisiting these topics for good reason. State control is undoubtedly necessary as certain tasks cannot be fulfilled by the market. Define the scope of optimal state intervention, however, is not a trivial task. The constantly changing social and state environment renders any fixed and permanent arrangement impossible. Equally, earlier models that were once sound at a certain institution or in a certain country may be ineffective in different formal or institutional contexts (*Tanzi 2011*). This approach is also reflected by the collection of studies *Ösztönző állam – hatékonyabb vállalatok* (*Motivating State – More Efficient Companies*), which undertakes to present a motivation- and cooperation-based model of state operation and its consequent efficiency.

Historically, economic thinking has altered according to the general perception of the state. What the different players would leave to the state largely depends on what they generally think about the state, and also about the state's counterpart, the market. This question is also related to where we can see value creation in the economy (*Mazzucato 2018*). Value theories have been rather dynamic and deep in recent centuries – and typically have given little recognition to state intervention. In the 17th century, trade enabling the accumulation of precious metals was considered the main value creator (by the mercantilists), then the focus was later shifted to agriculture and land (physiocrats). Classic economists believed in the strength of the industrial distribution of work and this belief was followed by the marginalist

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revolution praising the market as the creator of value. This created a rather negative perception of the state that still dominates the mainstream of economics. Since Adam Smith, people have unquestionably believed in the autonomy of the market. Two hundred years ago, the Scottish moralist-philosopher proclaimed that under certain conditions, the state could only boost the economy and create the most wealth by allowing market forces to operate autonomously, and this would help private interest work for the good of public interest.

Mainstream economic thought – mistakenly – classifies government as the "necessary evil", where the state is only capable of correcting the failures of the market (and only in a limited way, as it may quickly hit the wall of some government failure), overall the government is not productive and does not create value. This pro-market attitude has been criticised by many ever since its conception, and it has been fundamentally questioned by events of the past decade. The responsibility of market forces in the 2008 crisis was undisputable. This turned attentions towards the state, as it was the state who finally corrected the chaos of the market. An increasing number of signs indicates that the demarcation line is not between the market and the state, but rather between a well operated or badly operated state.

This novel and fresh attitude is supported by numerous studies in this 330-page collection including nine studies and two corporate governance case studies. Using practical examples and theoretical studies, these findings present an economic-political and public finance renewal of the Hungarian economy since 2010. They showcase the operating model of the Hungarian state taking shape from the changes of the last decade. This model recognises the outstanding role of the state in operating the whole market-economy system, the development of the market, innovations, value creation and the introduction and maintenance of efficient market operation.

The volume edited by Bianka Parragh outlines the theoretical framework of the economic policy followed since 2010, and demonstrates the operation of the model though practical examples. The year 2010 marked a clear demarcation line in Hungarian economic policy. Hungary was in an extremely weak state when it was hit by the global financial crisis in 2008. This was primarily due to severe financing and structural strains in the country in the pre-crisis period, which state economic policy tried to correct with erroneous and unsuccessful measures in the first years of the crisis management. These measures were concentrated on the supply side of the economy and were coupled with restrictions (*Matolcsy 2019*). The upturn in the economy began in 2010 and was implemented through 12 economic breakthroughs, largely built on the cooperation of fiscal and monetary policies (*Matolcsy – Palotai 2016*). This period and practice are embraced by this collection of studies too. The main message here is that the economic policy and public finance renewal since

2010 has raised the operation of the state up to a new conceptual and quality level today. Targeted motivation and trust as well as related cooperation between the state and economic players are at the heart of this new model. This is a motivating and supportive state approach, which at the same time targets predictability, stability and efficiency, supports the alignment of different branches of economic policy, and considers its contribution to sustainable competitiveness and long-term sustainable development to be key.

The volume of studies investigates the complex macro and micro level impacts of the motivating state attitude established since 2010, and the authors also outline of the possible directions of fine-tuning the state model. The list of names guarantees an overview of the players who were actually involved and shaped the events: along with Bianka Parragh and Gusztáv Bágер, members of the Monetary Council of the Central Bank of Hungary (Magyar Nemzeti Bank, MNB), other authors have contributed some chapters to this specialised volume, e.g. László Domokos, President of the State Audit Office, László György, State Secretary of the Ministry of Innovation and Technology, Richárd Végh, CEO of the Budapest Stock Exchange, and Joerg Bauer, Owner and President-CEO of the Tungsram Group.

The opening study by Bianka Parragh presents the development of state models and the changing phases of the role of the state. It details the model change of the Hungarian state after 2010 and the related crisis management steps in Hungary. The editor-author points at the various visible signs of the fruitfulness of the economic policy turnaround aimed at a more efficient harmonisation with the market. One of these signs is the increased impetus of economic growth based on a sustainable economy. In this regard, the fundamentals of growth are reduction of sovereign debt, increase of employment, development of education, intensification of investment projects, lending, research & development, equity investments and divestments, the moderation of the difference between GDP and GNI and the increasing level of community well-being. The volume of studies presents the role of the Fundamental Law of Hungary and its effects on public finance. In addition to theoretical premises, this volume offers numerous examples pertaining to a harmonious relationship between the state and the market. The best known examples of these are probably the tax and tax administration reforms, the shift in attitude to employment and family policies, the monetary policy breakthrough, the phasing out of the population's loans in foreign currency, motivation towards lending incentives of the central bank, development of the capital market, strengthening of the chamber system, making competitiveness an overall economic strategy objective, and the renewal of the attitudinal and methodological renewal of the State Audit Office. There is a detailed analysis on the conditions of corporate governance in the service of public interest in relation to the control of state-owned enterprises. On this topic, László Domokos concludes

that servicing public good requires an ethical governance system elaborated from a state management perspective. Gusztáv Báger takes on this train of thought in saying that the attitude and methodology of integrity can be effectively used by the private sector, i.e. by companies and financial institutions. László György and Dániel Oláh argue for a patriotic rather than a protectionist economic policy stating the objective that Hungary by 2030 should be in the five countries of the European Union where it is the best to live and work. László Parragh analyses the cooperation between the state, the enterprises, and mainly the SME sector, and highlights that a motivating state can equally be characterised by the provision of a predictable framework system for enterprises amidst a changing environment and striving for all the market players to be part of the cooperation. In this regard, the author identifies seven key areas affecting the prosperity of Hungarian small- and medium-sized enterprises: digitalisation, innovation, lack of labour, generational change, presence in the export market, productivity and corporate awareness. A separate chapter deals with integrity as a new concept and means of control, its role in state innovation, the role of the state in encouraging corporate innovation in the areas of knowledge management and digitalisation. A study by Richárd Végh details the opportunities of a motivating state in the context of the stock exchange and economic competitiveness, and it discusses the aspects of competitiveness of the capital market, while a separate chapter discusses the role of the Széchenyi Card Program in corporate lending. As a practical "imprint" of the formation of an efficient and diversely motivating state, the examples of two economic operators (the aforementioned Tungsram led by Joerg Bauer and Megakrán, a mid-sized company with a successful IPO) were presented.

This volume of studies describes the economic policy changes after 2010, which apart from being exact can also be easily used for research purposes and can dispel erroneous state-related stereotypes. Mainstream thinking has caused severe damage in public thought. The propagation of the omnipotence of the market and the failure of the state resulted in economic policy solutions directly leading to the financial crisis. The ethos of the public sphere has been largely eroded over recent decades, and the self-evaluation of the state has deteriorated significantly. In the meantime, as a result of the challenges that we are confronted with – increasing demographic pressure, geopolitical transformation, technological development, the transformation of money and climate challenges (*Virág 2019*) – the state has to undertake the task of solving the issues that the private sector cannot or is unwilling to solve. All this is especially and sadly topical against the background of the raging COVID-19 pandemic. Even though the development of the eagerly awaited vaccine is also contributed to by market players, proper state financing and a development strategy are fundamental and indispensable success factors.

This volume of studies is at the same time a profound professional work and an accessible document of our age. It also addresses the dilemmas of medium- and

micro-level economic control, presenting the reader with a prospective multi-level analytical framework. I can sincerely recommend this volume to economists, and to those outside this profession but who are interested in the model change of the past decade.

References

Matolcsy, Gy. – Palotai, D. (2016): *The interaction between fiscal and monetary policy in Hungary over the past decade and a half*. Financial and Economic Review, 15(2): 5–32. https://en-hitelintezetiszemle.mnb.hu/letoltes/gyorgy-matolcsy-daniel-palotai-en.pdf

Matolcsy, Gy. (2019): *A sikeres válságkezelés a 12 gazdasági fordulat tükrében* (*Successful Crisis Management in the Light of the Twelve Economic Turnarounds*). Polgári Szemle (Civic Review), 15(1–3): 15–45. https://doi.org/10.24307/psz.2019.0903

Mazzucato, M. (2018): *The Value of Everything: Making and Taking in the Global Economy.* Public Affairs.

Tanzi, V. (2011): *Government versus Markets. The Changing Economic Role of the State*. Cambridge University Press.

Virág, B. (ed.) (2019): *Long-Term Sustainable Econo-Mix*. Magyar Nemzeti Bank, Budapest.

Urban Development in China: A Regional Development Model with Challenges and Milestones*

Bence Varga

Juan Du:
The Shenzhen Experiment: The Story of China's Instant City
Harvard University Press, 2020, p. 384.
ISBN: 978-0674975286
Hungarian translation:
A sencseni kísérlet – A kínai „azonnali város" története
Pallas Athéné Könyvkiadó, Budapest, 2020, p. 440.
ISBN: 978-615-5884-90-0

Ever since cities have existed, urban development has been a constant challenge and required the continuous commitment of city management and city planners. Developments usually appear not as isolated phenomena: most of the times they should be viewed within the framework of a (geopolitical, economic or social) context. Challenges in this respect are posed particularly by periods of post-war reconstruction or economic downturn. Thus, we also need to know the history of the respective city or region to be able to put the urban development proposals, the relevant debates and courses of action into a proper context. In the absence of this, we can easily make the error of assessing the circumstances of the development of contemporary towns incorrectly. We may face exactly this mistake when assessing the rise of Shenzhen. According to the "myth of Shenzhen", the success of the city is primarily attributable to the economic opening of China and modern city planning as well as to the circumstance that Shenzhen has no major historical past, and thus during the planning of the city it was not necessary to take into consideration traditions or previously developed expectations, which otherwise could have represented constraints. However, this is not exactly the case. Because this statement ignores a number of important conditions, i.e. it does not give a clear idea of the facts. Shenzhen is not without historical traditions: there are more than 300 "ancient settlements" within the city, which developed from earlier,

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typically agricultural villages, thereby providing the city with a duality and a familiar atmosphere. The basic assumption of the author, contrary to popular belief, is that local negotiations, commercial relations and social networks were as important for the economic rise of Shenzhen as the factors listed before.

1979 is usually mentioned as the year of the foundation of Shenzhen; this is when the Special Economic Zone (SEZ) was created. Although similar zones were created in the 1960s in other countries as well, none of those countries had previously been able to produce real success. The creation of the Shenzhen SEZ was one of the first measures of the presidency of *Deng Xiaoping* in the period of 1978–1989, forming an integral part of China's opening and reform programme. Shenzhen was followed by the creation of the Zhuhai and Shantou zones. These zones were mostly modelled on economically successful Western countries, operating a free market economy. Naturally, these were initially created in the form of small, decentralised zones, and thus they could be regarded as a kind of market reform experiment (until 2006 these areas could only be entered in possession of a passport and visa). The SEZs were of key importance for the implementation of the Chinese reform, which was pioneered by Shenzhen, since it raised millions of Chinese citizens from poverty, and evidenced that the implemented market reforms and the concept of "socialism with Chinese characteristics" can work. These SEZs were subject to permanent criticism, particularly because their operation was surrounded by major uncertainty and – at least initially – they were unpopular. The report from 1982, entitled *"The Origin of Old China's Colonial Concessions"* formulated probably the most severe criticism, which regarded the SEZs as the hotbed of corruption, smuggling, money laundering and collaboration with hostile foreign countries as well as a "degenerate" solution (even within capitalism) and considered its operation as a disgrace overall. Nevertheless, also owing to the creation of the SEZ, between 1980 and 2000 GDP of Shenzhen rose by more than 40 per cent on average annually (from CNY 0.2 billion to CNY 200 billion), and by 2017 it had achieved tenfold growth (GDP rose to CNY 2.2 trillion), exceeding the GDP of most of Asia's largest financial centres. Due to the conditions of that era, jobseekers often spent several days and amounts as high as one year's wage on travelling to Shenzhen in the hope of a better job and more favourable opportunities. They did so despite the fact that due to the household registration system (known as *hukou*) in theory they would have not been permitted to migrate between cities. However, in 1984 the local government of Shenzhen provided employees with temporary residence, thereby making migration legal (after this several cities introduced similar measures, which ultimately led to the reform of the *hukou* system).

Thus, in retrospect, the SEZ was undoubtedly important for the rise of Shenzhen; however, in connection with this we need to point out two fallacies. One of them is that in China the purpose of creating the SEZs, contrary to popular belief, was not

to increase authority and create economic prosperity. Initially, the objective was much less ambitious: the Great Famine (1959–1961) and the Cultural Revolution (1966–1976) thereafter resulted in extreme poverty, and thus alleviating that was the most important consideration. Another common mistake relates to the year when Shenzhen was founded (1979), which – although it was obviously defined so due to propagandistic reasons – omits the importance of historical "legacies", including the fact that the history of Chiwan Port dates back to the Tang Dynasty (618–907) and that by the age of the Ming Dynasty (1368–1644) it has already become one of the key ports of South China, as an important connecting link to the neighbouring countries. Thus, it was a critical station also for the Silk Road (major local commercial goods, such as china, spices, salt[2]). In addition to trade, this area also stood out due to religious reasons; its role also appreciated due to the Chiwan Tianhou Temple located here and to the military rituals organised here. The Chiwan Temple gradually expanded over time and gained increasing importance: by the second half of the Qing Dynasty (1644–1912) it already had about 120 halls. However, we can go back even further in time based on historical records and archaeological research: in the years of the Han Dynasty (206 BC – 220 AD) the later Shenzhen (or as it was called at the time, Nunhai Prefecture) was already densely populated and in terms of its civilization, it was a developed region compared to contemporary conditions. The tomb of *Zhao Bing* (1272–1279), the only emperor buried in southern China, is also located here.

There are also many untrue assumptions about Shenzhen's population prior to urbanisation. According to the widely held view, in 1979 its population was merely 30,000, while in fact the number of inhabitants already then exceeded 300,000. The difference is only partly explained by the fact that Shenzhen was divided into two parts: the southern SEZ and the northern part of the settlement; however, even without the southern SEZ, Shenzhen had a population of 100,000 inhabitants. Referring to it as China's Silicon Valley, developed from a fishing village, should be also treated with certain qualifications. That is, referring to it as a ‚fishing village', lacking any special features, would suggest that China's Silicon Valley could have been established almost anywhere. However, this is not true at all. Shenzhen is a unique zone, where the various agricultural and coastal commercial areas as well as the communities of the central and peripheral regions were equally important factors for the growth of the city. For example, the former agricultural community in the Huanggang area used its own communal and political power as well as the

[2] Salt trade proved to be an extremely profitable activity during this period, as evidenced by the fact that the proceeds from this made major contribution to the construction of the Great Wall and the Forbidden City. Accordingly, it is no wonder that this was covered by imperial monopoly (in addition to the "iron industry" and the production of spirits), which largely contributed to Emperor Vu's reign of 54 years. And although most state monopolies were abolished in later centuries, the monopoly on salt production and trade was maintained until 1 January 2017.

regulatory loopholes during the urbanisation and city planning in order to preserve its current unique place in the new metropolis.

There was a construction boom in the 1990s, as a result of which *Di Wang* (i.e. *Land King,* referring to the amount of consideration paid for the plot) was completed by 1995, which – in line with the usual scales of Shenzhen – with its height of 384 meters was the tallest tower building of Asia. The introduction of occupational lease for the use of land and the related changes in real estate law made it possible to announce an international real estate auction in China for the first time in 1992. This was instrumental in the appearance of foreign investors and joint ventures in larger numbers. Based on the foregoing, it is not surprising that in 2011 yet a new record was set: i.e. the *KingKey Financial Tower* (or KK100, referring to the 100 floors), a 442-meter high skyscraper. At the same time, urban development posed significant challenges for the population as well. The term *"nail house"* refers to buildings, the owners of which did not accept the conditions offered to them by construction enterprises in exchange for the land they owned. That is, when investments commenced, those living in the area were offered other housing or compensation, which was not accepted by all owners. This created a stir internationally, but did not hinder the construction. The negotiations usually developed in line with the investors' expectations (not all owners undertook the long, costly and time-consuming legal procedures), but there were also a few rather special cases. One Chinese family won the lawsuit after a court procedure of almost 3 years, and was thus able to preserve its property in the "middle" of a financial centre. As a result of negotiations between investors and the heads of the districts, certain "villages" were able to survive within the financial centre, being special features of the cityscape of Shenzen even today.

Thus, the cityscape of Shenzhen is characterised by substantial duality, an example of which, among other things, is the Baishizhou quarter, which is the most densely populated area within Shenzhen with the highest number of buildings, but at the same time it is also the scene of robberies and gang fights. In the knowledge of these, it may come as a surprise that Baishizhou is located in the Nanshan District, which is the technological centre of Shenzhen. Nanshan District also hosts Alibaba and Tencent, the latter being the only social networking portal in the world, other than Facebook, with more than 1 billion registered users.

In addition, Huawei, ZTE, Philips and Lenovo also have offices here; by 2015 a total of 7,675 industrial and commercial enterprises were registered in the district. Shenzhen University, the city's oldest and largest university, is also located here. The university was founded in 1983, with computer science as its most famous faculty. A number of celebrities graduated from here, including Ma Huateng, the founder of Tencent. The *Overseas Chinese Town* (referred to as "Window of the World", "Splendid China" or "Chinese Folk Culture Village") is one of Shenzhen's

prides with its fascinating landscape, parks and modern buildings, due to which it also serves as one of the tourist centres of Shenzhen. A miniature version of the Eiffel Tower, the Potala Palace and many other attractions can be found here. And of all this is separated from the slum practically merely by a concrete wall.

The success story of Shenzhen is presented in many plays and films. One of the best-known books about Shenzhen, *"Heaven to the Left, Shenzhen to the Right*" is popular primarily with young people due to its noir style. In addition to presenting the obvious achievements, it also sheds light on problems such as housing difficulties or low living standards in the peripheral areas. The city plan for the period of 2019–2025 outlines the integrated rehabilitation of rural areas, but there are still many shortcomings and issues to be clarified in terms of specific procedures. Nevertheless, it is an excellent example of Shenzhen's desire for continuous development and change, which encourages other cities as well to grow. Although *Deng Xiaoping* forbade that a statue of him be erected in his lifetime, it is no coincidence that the only statue of the contemporary president outside his hometown can be found in Shenzhen, even though he visited Shenzhen only twice, in 1984 and 1992, and hardly spent more than one week there in total.

Based on the lesson learnt from the book, it is not easy to adapt the success of Shenzhen to other cities, since the achievements of Shenzhen are also attributable to many other, special factors. Therefore, it is more important that during city planning and urban development no attempts are made to follow or copy the Shenzhen model; instead, we should try to identify the yet undiscovered lessons learnt from the history of Shenzhen. This book provides genuine guidance on this.

Eurasian Cooperation in the Post-Pandemic Era – Report on the Budapest Eurasia Forum E-Conference*

Marcell Horváth – Patrik Pavlicsek – Nóra Anna Sándor – Péter István Szabó

On 27 October 2020, following the 2019 Pre-Forum Session, the Central Bank of Hungary (Magyar Nemzeti Bank, MNB) organised the Budapest Eurasia Forum Conference for the second time, and this time under the title of "Eurasian cooperation in the post-pandemic era". We are living in an ever-changing and dynamic era, in which unilateralism and the need for multilateral cooperation, protectionism and free trade, and the impact of a global technological revolution are present at the same time. Ensuring long-term sustainable development and growth is a key shared challenge for the countries of the region in this new era, for which multidisciplinary dialogue is essential, with particular emphasis on the geopolitical aspects of common goals. Enhancing the dialogue between Europe and Asia is significant not only from the perspective of 21st century megatrends, but also regarding the economic recovery from the coronavirus pandemic and multilateral cooperation. To this end, the MNB's series of conferences launched last year aim to provide a platform for European and Asian decision-makers and experts to enhance cooperation and dialogue. The forum's professional programme featured high-level decision-makers and recognised experts from China, Singapore, South Korea and several European countries on geopolitics and multilateral cooperation, the economy and finance, the future of smart cities and enhancing digital literacy.

A new world order began taking shape by the 21st century, leading to the effects of unilateralism and multilateral cooperation, protectionism and free trade, and the global technological revolution appearing in the global system at the same time. As a result of Asia's economic and innovation development, a shift in emphasis is unfolding in the international order, the central axis of which can be ensured by the cooperation between Europe and Asia, especially China. The Belt and Road Initiative (BRI), announced by Chinese President Xi Jinping in 2013, can be considered an official milestone in the new era, which will see the Age of Eurasia supersede the Atlantic Age. This expanding framework and directions of international cooperation

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The authors thank Eszter Boros, Georgina Juhász and Györgyi Puhl for their help in preparing the report.

covering Asia and Europe (New Silk Road, Digital Silk Road, Green Silk Road, Health Silk Road) show the pattern of the megatrends of the new era, which fundamentally determine the directions and nature of development. These megatrends can be the need and creation of long-term sustainable growth, including the technological revolution and the transformation of money, green thinking and the growing importance of geopolitics.

There is no doubt that we are living in an age of transformations towards a new world order, in which geopolitical cooperation initiatives are reshaping our international and economic relations, while parallel to this, the technological revolution is bringing radical changes to our daily lives, business, work or personal, and last but not least our health. Ensuring widespread sustainable growth and social well-being in the 21st century depends to a large extent on our ability to radically transform our economic models. The growing role of state-of-the-art technologies (robotics, AI), the promotion of social catch-up and the importance of protecting the natural environment are challenges that require rapid and effective solutions.

The events of 2020 gave new impetus to the unfolding transformation and further highlighted the signs of a change in era. The COVID crisis has presented the world with challenges that could not be prepared for. Nevertheless, the crisis is also a stimulus for development since it forces the decision-makers to adapt to the circumstances by reviewing previous solutions and seeking to implement even more effective and sustainable measures. The changes involve both risks and opportunities, but the common goal is to develop methodologies that help take full advantage of opportunities and reduce risks.

Thus one of the most important questions today is what answers can we give to the processes taking place in the world that pose economic, technological and geopolitical risks? The secret to success and competitiveness lies in how quickly and efficiently we can adapt to the changed circumstances. In forming this recognition that lays the foundation for the future, and in finding a solution, the renewal of economic thinking plays a key role. The series of events of the Budapest Eurasia Forum initiated by the Magyar Nemzeti Bank offers a new platform for this. The forum will focus on the future of cooperation between the countries of Europe and Asia and on how to ensure sustainable cross-border economic growth. By focusing on Eurasia, the event reflects on the geopolitical transformation taking place today and the shift in focus that is making Asia, especially China, one of the dominant poles of the world economy.

In light of the pandemic, the event took place on 27 October this year under the title of "*Eurasian Cooperation in the Post-Pandemic Era*". In line with the basic concept, the event's professional programme went far beyond the central bank and monetary policy issues in the classical sense, as achieving long-term sustainable economic

growth requires interdisciplinary dialogue that includes issues of innovation, technology, geopolitics and education as well.

The conference was opened by *György Matolcsy*, Governor of the MNB, who emphasised that we were at the dawn of a new era that would replace the Atlantic Age lasting since 1492. The Governor highlighted that the keyword in geopolitics and economic development in the 21st century was *long-term sustainability* permeating all areas of life, and that cooperation between regions had to take into account its geopolitical and economic aspects. The Governor pointed out that because of the pandemic, an unprecedented Eurasian coalition had been established in recent weeks and months, and China had supported European countries, including Hungary, in overcoming the epidemic. The pandemic seems to have developed a new type of solidarity in the relations between West and East. The world order is changing, according to the Governor of the MNB, serious consequences can be drawn from the events of the 1940s and 1970s, which could contribute to the promotion of Eurasian integration. The economy of the 1940s was not sustainable due to World War II, and the 1970s economy because of the oil crisis, which is why we need to learn from the mistakes of previous eras to create a sustainable Eurasian continent.

Xiaochuan Zhou, Vice Chairman of the Boao Forum for Asia and former Governor of the People's Bank of China (PBOC), also hold a speech at the opening ceremony of the conference. He stressed the importance of enhancing international cooperation in the current geopolitical and economic challenges, pointing out Hungary's particularly important role in strengthening the Europe-Asia dialogue. *Zhou* emphasised that in the post-COVID-19 world, digitalisation and the digital economy would play an even more important role than ever before. In his opening speech, the Vice Chairman of the Boao Forum for Asia outlined the Chinese digital currency project and the efforts made to promote electronic payments (DC/EP[1]). Mobile payment services are extremely popular in China, with the share of mobile payments reaching 57.6 per cent by June 2020. *Xiaochuan Zhou* also mentioned the factors that justify the development of DC/EP as well as the opportunities offered by the digital currency, including increased competition between commercial banks and telephone service providers.

Following the Vice President's speech, the Minister of Foreign Affairs and Trade *Péter Szijjártó* shared his thoughts on the East-West cooperation and Hungary's role in the Eurasian cooperation. The Minister emphasised that COVID-19 posed challenges to the world and had turned everyday life completely upside down. However, Hungary sees this new situation not only as a challenge, but also as an opportunity, which Hungary must make the most of. The Minister also spoke about

[1] Digital Currency/Electronic Payment

the government's Eastern Opening initiative launched in 2010, which he called successful based on figures from recent years: since the introduction of the strategy, Hungary's exports to eastern countries have increased by 22 per cent and its trade volume by 25 per cent. Also, in 2019, for the first time, Hungary's largest foreign investor was not Germany but an Asian country, South Korea. The role of eastern countries in the Hungarian economy is also supported by the fact that 60 per cent of foreign capital investments came from these countries, while 40 per cent of the newly created jobs were contributed by investments from Eastern countries too. *Péter Szijjártó* emphasised that Hungary is happy to act as a bridge between Europe and Asia, and that the government supports all initiatives that serve to strengthen the Eurasian region.

Hongbo Wu, Special Representative of the Chinese Government on European Affairs, former UN Under-Secretary-General for Economic and Social Affairs, addressed the opening ceremony as well. In his speech, he pointed out that countries around the world had to face challenges such as protectionism, unilateralism and increasing globalisation, as concerns are increasing, and that the coronavirus epidemic reached the world in these challenging times. The Special Representative also made some references to the future of China's foreign policy, adding that China's political goal is to conduct international relations peacefully and enhance cooperation, while its economic objective is to ensure innovative and green development. To meet the economic challenges posed by the coronavirus pandemic, smooth cooperation between Eurasian countries is particularly important and they have to work together to improve public health as well as to strengthen communication and information sharing between states. Attention must also be paid to promoting people-to-people contacts and supporting new drivers of growth, such as artificial intelligence, big data and smart manufacturing. *Wu* also referred to Sino-Hungarian relations, which were solid despite the pandemic.

The rise of Eurasia – Geopolitics and multilateral cooperation in the wake of COVID-19

The first panel following the opening speeches, entitled *"The rise of Eurasia – How COVID-19 may reshape geopolitics and multilateral cooperation"*, focused on geopolitical changes in the post-pandemic period as well as issues related to multilateral cooperation. The panel was moderated by *Mihály Patai*, Deputy Governor of the Magyar Nemzeti Bank responsible for international relations, cash logistics, financial infrastructure, digitalisation and credit promotion. The panel discussion was attended by *Mehmet Huseyin Bilgin*, Vice President of the Eurasia Business and Economics Society, *Zhimin Chen*, Vice President of Fudan University, and *Pierre Heilbronn*, Vice President of Policy and Partnerships of the EBRD.

In response to a question on the impact of the pandemic on international relations and new trends in cooperation between Asian and European countries, *Zhimin Chen* said that the coronavirus pandemic had disrupted international relations including border closures and uncertainties in global production and supply chains, and it also gave way to the strengthening of populist and extreme nationalist thinking. On the other hand, he added that all these problems needed to be addressed at source, and not magnified, as digitalisation still allowed for the organisation of online international meetings, business negotiations and multilateral forums, and society was able to function as usual thanks to today's advanced technologies. At present, digitalisation connects the world and ensures that a global collapse is avoided, as well as creating opportunities for further digital development. The mutual assistance between countries is proof that, despite the difficulties, the relationships between West and East can continue to develop this year as well. The Vice President mentioned the increase in rail freight traffic in Eurasia as an example. *Zhimin Chen* also highlighted that no revolutionary and fundamental changes could be seen in the system of international relationships and world politics owing to COVID-19 so far, but two factors could have a significant impact in the future. One is the faster development of "connecting paths" between countries, namely land (rail) and digital connections, including the expansion of Eurasian rail lines, and the other is the dynamic development and resilience of East Asia in the Eurasian region. The rapid response and resilience of the East Asian region and China towards the pandemic could be a driving force in the Eurasian region and may stimulate the innovative and technological development of the countries. The current situation is an opportunity for change in terms of both international politics and technological innovation.

Mehmet Huseyin Bilgin and *Pierre Heilbronn* agreed with *Chen's* thoughts. In *Bilgin*'s view, the pandemic shed light on new aspects of cooperation. Cooperation between Asian and European countries, including regional cooperation within the framework of the BRI, will display an increasing trend and will be essential in the post-pandemic period, as well as forming the basis for green renewal within Eurasia as well. The global pandemic significantly increases the economic risks for developing countries and can also have a strong negative impact regarding global inequalities. According to *Heilbronn*, while the crisis caused by the pandemic has posed many challenges to countries around the world and is teaching everyone to be resilient, it also offers plenty of opportunities. The current situation shows the effectiveness of the economic development models used so far as well as creating new development paths. Also, the crisis has highlighted the need to accelerate the digital transformation.

Analysing the role of multilateral institutions, *Vice President Heilbronn* spoke about the fact that the EBRD and other international institutions naturally give priority to

support for states with limited financial resources during the crisis as well. In his view, only multilateral cooperation and joint action can create an opportunity for recovery in Eurasia. *Heilbronn* highlighted that green bonds play a very important role in sustainable development, so the EBRD is present in the green bond market both as an issuer and investor, as evidenced by their recent target of ensuring green bonds account for 50 per cent of their investments by 2025. The EBRD has always been open to developing partnerships with other international institutions and has supported the work of the Asian Infrastructure Investment Bank (AIIB) from the outset. The EBRD believes building relationships that support a sustainable economy and flexible supply chains is important in both directions, so they count on the work of not only the international European institutions but also of the Asian ones. The EBRD is a special laboratory from the aspect of Eurasian partnership and multilateral cooperation. Cooperation between these institutions is also extremely important, as is the development of a 'common agenda', where the trust between countries would be increased by jointly developed standards which would also contribute to mutual understanding. Regarding the New Silk Road project, *Zhimin Chen* underlined that the BRI initiative focused on infrastructure developments (construction of roads, bridges and power plants) at the beginning, but over the years the Chinese expanded the project and intensified cooperation along three more "silk roads" the construction of which is not only of Chinese but also of global interest. These are the *Digital Silk Road*, the *Health Silk Road* and the *Green Silk Road*. The Digital Silk Road has become more appreciated in the current situation because the role of digitalisation is crucial to overcoming the impacts of the pandemic.

Reflecting on the cooperation between CEE countries and Turkey, *Bilgin* emphasised that the potential of relations between the two regions lay in being a bridge between West and East and in adopting a strategic position in global trade, production, energy security and health cooperation as well as migration problems. Close cooperation between countries and regional cooperation are also particularly important for exploiting these opportunities. According to the participants in the discussion, one task for the future will be to create a common platform not only focusing on issues related to politics, economy, climate change, sustainability and energy strategy, but that these would also be complemented with the discussion of health and digitalisation issues for the 21st century.

Challenges and opportunities for sustainable growth in Eurasia

The second panel of the Budapest Eurasia Forum, entitled *"Well-balanced and sustainable growth in Eurasia after COVID-19 – Changes, prospects and the future"*, was opened by *Barnabás Virág*, Deputy Governor of the Magyar Nemzeti Bank responsible for monetary policy and financial stability, who introduced the topic by saying that COVID-19 had brought about tectonic changes, including accelerating

digitalisation processes for example, as well as being a significant game changer for decision-makers, too. The crisis caused by the coronavirus pandemic is deeper and more widespread than the financial crisis of 2008/2009 was, which he evidenced with a few figures: in 2020 some 30 countries around the world will experience a decline in GDP of more than 10 per cent, compared to 2009, where the same number was 7. As a result of the current crisis, central banks around the world used the tool of monetary easing and increased their balance sheets. In addition to monetary policy, *Barnabás Virág* also emphasised the supporting role of fiscal policy which can alleviate the negative economic effects of the crisis. Spearheading the recovery from the crisis is China, an Asian country that will continue to expand in 2020, despite more than two-thirds of countries sinking into recession this year. The Deputy Governor added that the European Union's economic performance could lag behind the Asian region this year and next. In his view, the coming years and decades will be determined by sustainable development and digitalisation.

The keynote speech of *Kyuil Chung*, Deputy Governor of the Bank of Korea, was built on precisely these two main topics, green growth and enhancing digitalisation. To overcome the profound economic impacts of the pandemic and to support the economic reforms of the South Korean administration already underway, the government unveiled the new USD 133.1 billion economic development strategy for the Asian country, the Korean 'New Deal' programme, in the summer of 2020. The government has high expectations of the strategy, and the project will enable South Korea to play an even more decisive role in the world economy after COVID-19. The main goals of the strategy are for South Korea to transform from a "fast follower to a first mover", to help the transition to a carbon-neutral economy and to develop an inclusive social system from an unequal society. The three main pillars of the project are the *Digital New Deal*, the *Green New Deal* and the *Stronger Safety Net*, and the administration is planning to restructure the economy along these three lines. The Digital New Deal aims to maintain and further develop South Korea's competitive advantage in infocommunication technologies by creating a modern, digitally driven economy and society; the purpose of the Green New Deal is to ensure sustainable development and a carbon-neutral and energy-efficient transition of the current economic system, while the third pillar calls for the structural transformation of the country's labour market and the strengthening of its social safety nets. *Chung* also referred to the digital currency (CBDC) project of the Bank of Korea, where testing could begin in 2021.

Qi Zhang, Director-General of the Development Research Center of the State Council of China, took a similar view, stressing that the coronavirus pandemic has shaken the world economy to an unprecedented extent. In her keynote address, *Zhang* emphasised that the pandemic also posed challenges to multilateralism and international cooperation, but in addition to the disadvantages, the benefits must

also be recognised and the opportunities offered by the pandemic must be seized, such as digitalisation that became a new driver of economic growth in the recent period, and in the future this trend will only intensify. The Director-General stressed that due to China's timely control of the epidemic, and the fact its economy rapidly resumed growing, investments increased by 5.2 per cent in the country in the first 9 months of 2020. *Zhang* said China's goal in the coming period is to promote open and inclusive economic cooperation, which will allow further market opening and bring benefits to all parties.

In the panel discussion following the keynote speeches, *Bofei Hu*, Deputy General Manager of the China Construction Bank, *Danae Kyriakopoulou*, Chief Economist and Director of Research of the Official Monetary and Financial Institutions Forum (OMFIF), *Sopnendu Mohanty*, Chief FinTech Officer of the Monetary Authority of Singapore (MAS) and *Changchun Mu*, Director-General of the Institute of Digital Currency at the People's Bank of China attended and answered questions related to globalisation/deglobalisation processes, the rising debt levels of states, the situation of commercial banks, and central bank digital currencies, among other things.

Mohanty and *Kyriakopoulou* shared their thoughts on globalisation and deglobalisation trends. According to the MAS expert, during the pandemic the emphasis shifted from efficiency and productivity to resilience and sustainability, and the role of the high-tech economy became all the more important. There has been an increase in electronic payments in Singapore and Asia, especially around retail payments, where this was not common practice before the pandemic. An important challenge in the future, according to Mohanty, is that economic policymakers need to find the right infrastructure and solutions for cross-border data flows. OMFIF Chief Economist *Danae Kyriakopoulou* called for global action to recover from the pandemic as well as stressing the need to reduce social inequalities and take aspects of sustainability into account. The increased debt levels also call for decisions at international level, especially for poorer countries, but this process has already begun. The leading economist also reflected on the debt to GDP ratio and said that the debt level should be looked at more holistically, as it is a ratio which includes GDP itself, and if borrowing reduces its decline, then it will also make the actual debt more sustainable. Much depends also on combining different policies too. At present, higher fiscal policy expenditures represent the right path, but there are also risks to reliance on stimulus packages, and this is especially true for monetary policy stimuli.

Bofei Hu representing China Construction Bank shared her thoughts with the audience on the role of commercial banks after COVID-19 and the changes due to the pandemic. *Hu* pointed out that the commercial banking sector is undergoing three major changes in the wake of the coronavirus: to begin with, the global recovery will be lengthy and unbalanced and it will be shrouded in uncertainty; secondly, the

loose monetary policy is increasing liquidity and causing volatility in asset prices; and thirdly, the impact of the crisis varies by sector, with tourism, for example, being particularly hard hit. Meanwhile, some industries are recovering quickly and taking advantage of the potential of online sales and digital transformation. With regard to Chinese commercial banks, she added that the institutions had reached a consensus that serving the needs of the real economy was the main goal. Banks themselves have made great strides in digitalisation, with China Construction Bank, for example, providing loans to SMEs and family entrepreneurs during the epidemic via a mobile application, which has the advantage of enabling quick loan applications, in just a few minutes, while the disbursements and repayments are made online too.

The topic of central bank digital currencies was discussed in the remaining time of the panel discussion. On the potential introduction of the CBDC, *Changchun Mu* shared his thoughts, saying he sees several turning points when a central bank may want to introduce a digital currency. One example of this is that if the use of various private digital means of payment (issued by private actors) increases, the central bank should consider introducing a CBDC to protect financial sovereignty. Furthermore, if retail payments are operated by private payment service providers (e.g. Alipay, WeChat Pay in China), this system has its own (technological) life cycle risk, such as downtimes and outages. In such cases, the central bank must intervene through the CBDC by providing a backup solution. The introduction of the central bank digital currency can also be stimulated by shortcomings in the central bank's own payment system. Finally, if a country has a large population and those living in less developed, remote regions may not yet have access to (traditionally operating) financial services. Increasing access (financial inclusion) can be an incentive for central banks too. *Mu* also pointed out that the PBOC has distinguished three different categories during the CBDC development process: token, account and current account-based pathways, but any of these will be usable in their system and he has no personal preference.

On the question of whether there could be some sort of preferred order of introduction for different types of CBDCs, *Mohanty* highlighted that the Monetary Authority of Singapore was the first to think about the possibility and role of a CBDC for clearing between credit institutions. In Singapore, banking services are widespread – with more than 95 per cent banking coverage among the population – so there is no real need for a separate CBDC to be used by both the public and companies. Money can be transferred from one account to another in a matter of seconds, virtually free of charge. At the same time, the primary focus of the CBDC for clearing between credit institutions is operational efficiency, which may solve long-standing problems in interbank transactions. This is especially true for cross-border interbank transactions. Central banks can use this type of CBDC in international settlements, making them cheaper, faster, more secure, and much

more efficient. SME transactions basically consist of two steps: one is the delivery of the product and the other is the (post-delivery) payment. These two separate processes can also be combined through smart contracts, in which the CBDC for clearing between credit institutions also plays a role. A smart contract is a single transaction that includes payment, thus eliminating the risk of uncertainty and non-payment.

At the end of the panel, *Barnabás Virág* asked the participants about the introduction date for the CBDC. *Bofei Hu* pointed out that the Chinese may already have experienced CBDC to some extent as they are already experimenting with it in several major cities. The participants in the experiment quickly adopted the central bank digital currency and were actively involved in its use. Its application is very similar to what they are already used to in the already widespread use of digital payments, so she believes it may be introduced in the near future. *Kyriakopoulou* also referred to the Chinese example and added that its introduction in China is already imminent. However, the introduction of a truly international, so-called *synthetic global digital currency* that has already been raised in the past will not happen in the near future. Some central banks have taken some steps in the euro area, but as we are talking here about the framework of a common currency, it will take significantly more time. *Mohanty* pointed out that Cambodia has already issued a kind of CBDC, which is a good indication that digital money offers a huge leap by making it possible to avoid building a traditional and expensive retail payment system. In terms of the CBDC for clearing between credit institutions, he said it is expected to appear as early as next year. *Mu* also agreed with the previous speakers, but indicated at the same time that although China had already started a pilot programme, this was not yet an official introduction. Further preparations are needed regarding both the technical and legal aspects.

Smart cities for a healthy future – Thoughts on innovative urban development and digital literacy

The third panel of the forum entitled *"Smart cities for a healthy future? Innovation in Urbanisation and the Importance of Digital Literacy"* focused on smart city developments and the aspects of digital literacy in response to effects of urbanisation experienced worldwide. The panel was moderated by *Norbert Csizmadia*, President of the Pallas Athéné Domus Meriti Foundation (PADME), who in his introductory thoughts highlighted the importance of connectivity, the key role of digitalisation in the future and the *"fusionopolis"* phenomenon created by the international cooperation of smart cities. *Norbert Csizmadia* also briefly outlined the main issues discussed in his book entitled *Geofusion*, which, in line with the theme of the panel, examines the effects of digital transformation and state-of-the-art technologies on urban life and urbanisation, among other things.

The basic ideas of the panel discussion were formulated in a speech by *Jianduan Jiang*, Director-General of China State Construction and Engineering Corporation, and a presentation by *Eng Chye Tan*, President of the National University of Singapore. As the head of a large Chinese corporation, *Jiang* also stressed that the COVID-19 pandemic has triggered significant changes in the multipolar world order that need to take humanity even more in the direction of openness, cooperation and development. The company dealing with the development of smart cities is involved in implementing tens of thousands of projects every year, thus it has significant experience in sustainable urban infrastructure development. *Tan* outlined the smart city programme in progress in Singapore, which he saw as a model for smart city development. Highlights of the programme include residential-centric, open-access design, cloud-based design, and data sharing — all in the context of cybersecurity and data protection. In practice, this also involves inclusive digital training and skills development for the population, which require the setting up of new virtual networks and a digital helpdesk too. A solid IT infrastructure, secure and reliable data architecture, a regulatory framework and a digitally educated population are essential for the sustainability of cities of the future. According to the researcher, the pandemic has significantly slowed Singapore's economic growth down, but also created an opportunity to continue digitalisation.

Following the thought-provoking speeches, four panelists reflected on the above topics in a moderated discussion: *Leena Ilmola-Sheppard*, Senior Scientist, International Institute for Applied Systems Analysis, *Li Jin*, Executive Vice President of Fudan University, *Bruno Lanvin*, President of the Smart City Observatory, and *Jung Hoon Lee*, Chairman of the Smart City Committee of the Seoul Metropolitan Government and Professor at Yonsei University. The speakers agreed that we are moving towards a technology-oriented society which should be followed by the corporate sector, the labour market and the transformation of society. To do this, smart cities must set up supply systems that act as safety nets and provide the population with demonstrable and tangible practical benefits. It is important to note that smart city initiatives can exhibit spectacular results, especially in overcrowded, socially disadvantaged cities. The situation caused by the pandemic has clearly highlighted solutions that can also be applied to the concept of smart cities, such as the QR code-based health system (Shanghai Health Code Open Platform) introduced in Shanghai. On the problems of trust among users, the panel participants see the answers in a regulatory framework, in expanding the knowledge of the population, in the paradigm shift and in more open information management. The experts participating in the discussion stressed the importance of human capital development and talent management, which is supported by more and more digital solutions.

The panel's concluding idea assessed the regional-based similarities and differences of smart cities: the experts say that clear differences can be identified between the initiatives determined by local, specific cultural backgrounds and needs, thus individual solution strategies are born everywhere. As for the disparities, the preference for sustainable solutions is a regional feature of Europe, while in the case of Asia, most projects focus on public transport developments. By combining the characteristics of the two regions, a more adaptable smart city model can even develop in the long run, the basic conditions of which are improving connections and building on the basis of similarities.

The successful 2020 event was supported by the *Shanghai Forum*, the *Fudan Development Institute*, the S*ingapore FinTech Festival* and the Austrian-based *International Institute for Applied Systems Analysis*. Thanks to the digital platform, the event reached nearly 2,000 viewers.

The full event can be viewed on the conference website: https://mnb.hu/eurasia.

Report on the Sessions on Finance, Competitiveness and FinTech at the 2020 Virtual Annual Congress of the Hungarian Economic Association*

Ferenc Tóth – Katalin Juhász – Bálint Danóczy

The 58th – but first virtual – annual congress of the Hungarian Economic Association (HEA) was held on 24–25 September 2020. It is one of the most traditional and at the same time largest annual conference of the community of Hungarian economists. In addition to the opening and plenary sessions, the video recordings of the panel discussions of 15 thematic sections of the annual congress could be watched on the internet. The keynote speeches were delivered by *György Matolcsy*, Governor of the Magyar Nemzeti Bank (MNB); *László Domokos*, President of the State Audit Office; *Tamás Freund*, President of the Hungarian Academy of Sciences, and *Bertalan Farkas*, Retired Brigadier General, Astronaut. In addition to the live broadcasts, more than 80 experts in 15 sections participated in the pre-recorded thematic panel discussions. This report provides information about the roundtable discussions of bank leaders, the panel discussion of the Competitiveness Section as well as the roundtable discussions of the FinTech and Financial Culture Section.

There were roundtable discussions held with the moderation of *Barnabás Virág*, Deputy Governor of the MNB. Participants included *Éva Hegedüs*, President and CEO of GRÁNIT Bank Zrt., Secretary General of the HEA, *Ádám Balog*, President and CEO of MKB Bank Nyrt., President of the Central and Eastern European Section of the HEA, *László Bencsik*, Deputy CEO of OTP Bank Nyrt., *Radovan Jelasity*, Chairman and CEO of ERSTE Bank Hungary Zrt., President of the Hungarian Banking Association, *Pál Simák*, Chairman and CEO of CIB Bank Zrt., *Balázs Tóth*, Chairman and CEO of UniCredit Bank Hungary Zrt. and *József Vida*, President and CEO of Takarékbank Zrt. *Barnabás Virág* introduced the topic with a general assessment of the current situation. At the end of August and in early September the second wave of the coronavirus pandemic appeared, and this is what is fundamentally affecting the global real economy and money market situation. According to the current position, the recovery is to be slower and more protracted compared to previous expectations; the rebound is expected to take on the shape of a 'pipe' rather than

* 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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a 'V'. If a vaccine is successfully developed next year, growth may also recover. Real economy shocks only appear at full strength in the banking sector with a delay, as was seen following the 2008 crisis as well. At macro level the Hungarian economy was hit by the crisis in a fundamentally good situation, and the same is true for the Hungarian banking sector as well. All the indicators describing the resilience of the banking sector are in a far better state than they were in 2008 and in subsequent years, although the worst is yet to come. In any case, Hungary's starting position is sufficiently strong and stable, and the banking sector is prepared for the negative implications of the crisis caused by the pandemic.

In this context, the two questions of the first topic were what we and individual banks are better at compared to 2008 and 2009, and what else we could have prepared for in the past decade. Bank leaders revealed in their replies that the banking sector strongly supports the boosting of economic growth. Banks have become much more digital, they were able to switch their operations to home office within days, and they succeeded in rechanneling their customers to digital and remote channels. This enabled them to protect the health of their staff and customers. In addition, lending is much more prudent, partly as a result of the macroprudential rules that were introduced. This means that banks have significantly lower risk portfolios than during the previous crisis. An important difference is that there is no dependence on external financing; banks have learnt how to manage a crisis, and they operate in a much more transparent manner. Lending takes place in an appropriate manner, the number of fixed-rate and long-term loans is increasing, and practically there is hardly any foreign currency lending to households. Perhaps a national capital programme would have been needed 2–3 years ago. The macroeconomic environment is better now, and the regulator has introduced many changes influencing banks' operations. Even more attention should be paid to the efficient functioning of guarantee systems. The Hungarian banking sector is very developed digitally; the instant payment system has been introduced successfully. It was even possible to direct previously unthought customer groups – e.g. pensioners – towards digitalisation. Nevertheless, there are customers who returned to bank branches after May. Teaching customers how to use the digital space is still an important task. Amending the law would allow banks to provide even more financial services digitally, e.g. in mortgage lending.

The next topic was the issue of moratorium and vulnerability. *Barnabás Virág* said that households typically used the moratorium in the case of unsecured consumer loans, whereas the participation rate of SMEs is more significant. Based on income position and payment difficulties, 10–15 per cent of debtors may be vulnerable in both segments. The success of the moratorium justified its targeted extension. In the opinion of bank leaders, more customers are exiting the moratorium and few are entering again. Hungarian households' income position is good, but the

moratorium may help those who really need it. Clearly, tourism, catering and the arts are some of the affected sectors, but manufacturing as well, because this is where the fall in global demand might crystallise. At present it seems that the non-performing loan portfolio will not cause any major difficulties for the banking sector, but this largely depends on how long the recovery process will be. In addition, it is important what the quality of lending and the owners' commitment were like, but this is still hard to judge today.

Fortunately, both fiscal and monetary policies have ample leeway in Hungary, and thus the country can come out of this situation as a relative winner. At present, a significant number of businesses are interested in liquidity loans rather than development or investment loans. If liquidity loans run out, and the economy cannot start, further steps may become necessary. Monitoring is particularly important in the sectors that are most affected by the crisis, to enable banks to identify the most critical problems together with their customers.

On lending, *Barnabás Virág* said that it – understandably – decelerated with the outbreak of the crisis, but state programmes fortunately supported the household loan market. In his presentation he indicated that the 5 per cent VAT rate may stop the drop in the construction of new homes. Bank leaders said that the greatest fall in lending is seen in personal loans, which shows the cautiousness of retail customers. In a crisis, customers become more cautious, and they strive to save and reduce their consumption as far as possible. At the same time, they are optimistic about the future, and therefore the borrowing of housing loans soon returned to the pre-pandemic level, while strong lending is expected in the future as well in this area. *Barnabás Virág's* next question was what the new 'star product' may be in connection with savings, being aware of the fact that Hungarian households are quite conservative in their thinking here. According to bank leaders this is still uncertain, but currency exchange activity has strengthened recently for example. It would be important to inspire confidence and find a way of returning the huge amount of money held by households to the economy. The MÁP+ government security is still a good savings option for households, and the number of retail customers showing up at the stock exchange is also growing, although it would be good for them to learn when to buy and when to sell their stocks. Switching to the corporate segment, Barnabás Virág demonstrated that annual corporate loan dynamics had declined to 8.4 per cent due to the consequences of the coronavirus. The size of the state guarantee programmes announced as a result of the coronavirus exceeds the figure for Hungary in many European countries. A clear change in trends is observed in this respect; the number of those using guarantees is increasing. Bank leaders said that the six-year Crisis Guarantee Programme is a great opportunity, but it would be good if it were increased to ten years and the conditions for participation became simpler, and if the current high guarantee

fee was reduced. It would also facilitate lending if the individual government measures, including the guarantee programmes, and the conditions of the MNB's credit schemes were harmonised. In practice, beyond credit and guarantees, the real solution would be to provide capital.

Digitalisation, and the future of banking in a wider sense, was the last topic. *Barnabás Virág* quoted Bill Gates to introduce the topic: 'b(B)anking is necessary, banks are not.' The banking sector managed to cope with and 'incorporate' the challenge posed by FinTechs, while the coronavirus pandemic is a serious challenge for FinTech firms as well. The crisis situation is clearly creating numerous opportunities for the FinTech sector, as they are very prepared in terms of IT and they reach young users very fast, but there are risks as well, and there may be operational uncertainties. In addition, there are many central bank digital currency projects going on in the world, a possible consequence of which is that the central bank balance sheets may become available for households as well. A central bank digital currency is expected to appear in the world in about 1–5 years. Bank leaders drew attention to the fact that regulatory arbitrage may be an advantage for BigTech firms over banks. The role of regulators is very important in ensuring that the same rules apply to the same financial service irrespective of the provider of the concrete service. Banks integrate the new technology and innovation knowledge of FinTech firms into banking operations. The advantage of BigTechs over FinTechs is that the former know their customers' behaviour, but, similarly to FinTechs, the basic question here as well is what rules they would apply when providing financial services. Banks feel that customer confidence and customer relations are missing in the case of FinTech firms. A lack of confidence is also an issue in the case of BigTechs.

On the whole, some optimism was perceived among the participants concerning both matters, in spite of the crisis caused by the coronavirus and the expansion of BigTechs.

The Competitiveness Section of the HEA held its section programme for the fifth time in 2020. The topic of the section was the main megatrend of our time, i.e. the digitalisation megatrend, which is being experienced to an even greater degree in the pandemic. The roundtable discussion was entitled *Accelerated digitalisation – A smooth sea does not make a skilled sailor*. The panel discussion about the various aspects of digital competitiveness – such as smart parking, digital health care system and education – was moderated by *Ákos Szalai*, Head of the MNB's Competitiveness and Structural Analysis Department. *Tibor Somogyi*, Managing Director and Founder of DokiApp, *Zoltán Gyarmati*, Board Member of EPS Global Zrt. and *Tibor Prievara*, author of the Tanárblog (Teacher Blog) participated on the panel.

First, *Tibor Somogyi* explained the concept of telemedicine, what role it may play in our lives, and how the demand for telemedicine services changed during the pandemic. Telemedicine covers all health care activities supported by information and communication technologies (for example establishing a diagnosis, counselling), which are not linked to the physical presence of a doctor and patient; these activities first appeared in the world 6–7 years ago. Among other things, these services were created due to misinformation or exaggerated diagnoses available publicly (for example online), which were to be prevented by online consultations with real doctors. One great advantage of these services is that – after noticing their symptoms – patients can receive information as well as a precise and professional diagnosis without having to wait. Regarding the impact of the pandemic on telemedicine, a large sample survey (with 28,607 samples) conducted in the USA was highlighted. According to this survey, the ratio of those who intend to try digital health services increased from 18 per cent to 30 per cent, while the ratio of those who have already tried them was up from 11 per cent to 15 per cent. As a result of the restrictions due to the virus, more than 50 per cent of the doctors participating in the survey had started to use telemedicine. The speaker presented the operation of DokiApp, which is a telemedicine service that allows consultations with doctors and psychologists through video calls.

Thereafter, *Zoltán Gyarmati* spoke about the current opportunities and progress of smart parking and the smart city concept. The problem in bigger cities is that drivers cannot find empty parking spaces in the busiest parking areas and in public areas, and they do not have information on the capacity utilisation of car parks in the city, and thus the long search results in lost time and money as well as environmental pollution due to CO_2 emissions. According to EU studies, in cities with more than 1 million inhabitants an average driver spends more than two weeks a year looking for parking spaces. In addition, parking charges are a traffic-mitigation tool for local governments, and data regarding traffic and parking capacities also help to set these charges. Smart parking systems operating as parts of smart city systems offer solutions to these problems. One such smart parking enterprise is EPS Global Zrt., which mainly operates in China and basically collects, processes and shares data. They also develop cloud software systems that collect the data of various (geomagnetic, optical) sensors, which are then processed, consolidated and shared with drivers looking for parking spaces as well as with the institutions that operate the car parks. The shared data contain the traffic and capacity data and the average parking time, and there is an application that directs drivers to the parking space closest to their destination. In addition, intelligent traffic signs that indicate the number of parking spaces currently free in a given area are also installed.

During the third presentation, *Tibor Prievara* shared his thoughts on the challenges and opportunities of digital education. First, a paradigm shift was mentioned

with regard to what a student has to know to be prepared. In the 19th and 20th centuries the objective of teaching was to enable pupils and students to use well what they learnt in practice. By contrast, in today's rapidly changing world the main issue is whether they will be able to do well what they have not even learnt yet, the speaker said. In his opinion, these days students have to learn how they can acquire new skills to be able to adapt flexibly and successfully to the rapidly changing labour market needs of our time. Based on a study, a phenomenon was presented according to which, between 1960 and 2002, the ratio of routine or manually performed tasks of employees at firms steadily declined, while the ratio of creative work requiring analytical and interactive abilities grew dynamically. According to a survey, companies considered the abilities of cooperation, moderate and experienced ICT use, self-regulation, problem-solving skills, knowledge building and extended communication to be the most necessary skills an employee should have. In addition, the speakers also drew attention to the use of digital tools within reasonable limits. As a lesson from teaching during the quarantine, or quarantine pedagogy, it was emphasised that it is worthwhile for teachers to use the same platform and communication channel at the same school, and digital education should also be treated appropriately and used primarily for what it is good for. Namely, it is not suitable for teaching many fundamental skills (e.g. writing or integrating first-year children into community). Adjusted to the needs related to changed abilities, the training framework developed by the educational expert strives to provide feedback not only on students' material knowledge, but also on their so-called soft skills.

First, the issues concerning the speakers as entrepreneurs were discussed in the panels following the presentations. While thinking about the domestic entrepreneurial ecosystem, it was revealed that Hungarian public administration provides both financial and knowledge support to SMEs able to export. The availability of trained labour is also considered excellent in Hungary, which is an integral part of Hungary's competitiveness too. From the support schemes, the Modern Cities Programme was mentioned, which facilitates urban development in Hungary. Digitalisation is a precondition for the success and competitiveness of businesses. For online undertakings it is crucial to be able to measure their own performance (e.g. measuring turnover, web analytics, efficiency of applications, feedback from users). Major state-developed schemes like the Sulinet Digital Knowledge Base, the National Public Education Portal or the eChalk Database are actively present in the educational market.

The managing director of DokiApp emphasised that the virus situation accelerated the domestic digitalisation megatrend, and therefore early acceptors as users are expected to appear earlier in the area of telemedicine. As a projection of the digital megatrend to health care, the Electronic Health Service Space was

established providing online access for physicians to the list of prescribed and purchased medicines, and among other things they can also issue e-referrals to patients without completing forms on paper. One example of this progress is that at legislation level a telemedicine decree was also adopted, which will probably soon be followed by an act as well, meaning that a health care service provider can be an official health care providing institution as well. According to the author of the Teacher Blog, special attention needs to be paid to the changes that we will retain in the area of education, and possible difficulties (e.g. uneven internet service provision) must not discourage teachers and students from using digital platforms. The board member of EPS Global Zrt. highlighted the importance of adjusting rapidly to the new 'compulsion' caused by the pandemic, during which they learnt to place the knowledge transfer of the enterprise into online space.

Thereafter, *Ákos Szalai* asked the entrepreneurs what is needed – either on the regulators' or the entrepreneurs' side – to preserve the positive things brought about by the crisis when normality returns. According to the participants in the conversation, all actors should be prepared and have long-term solutions ready due to the uncertainties of the virus situation. A uniform ERP system, a reporting system, may be good tools for businesses, through which it can be identified where improvements are necessary in a process without any personal presence. It is expected that the transfer of know-how will accelerate, because its fastest possible sharing within the company, in the form of e-learning for example, will become necessary for operations. As regards e-learning, in the area of teaching, especially digital teaching, it is not enough if online tools are available, as it is the teacher who determines what they are used for by the children. It can be considered efficient practice if given working groups or areas briefly report on their activities in a targeted manner through online calls, instead of meetings.

Finally, the moderator asked what practical advantages the digital solutions of the three areas provide for their users, whether they are drivers, patients, students or teachers. According to the respondents, these solutions essentially result in an increase in efficiency. Nevertheless, the situation is more complex in the case of education, as students go to school not only because of the educational materials, but also for social learning. In the case of purely online teaching, students' social relations with their peers have declined. In terms of increasing efficiency in education it is important to note what is made more efficient by digital teaching. Therefore, instead of tests where cheating is possible, or multiple-choice tests, independent processing of a subject can be proposed, for example. Nevertheless, these tasks cannot definitely be considered efficient, this will only be confirmed or refuted in the longer term. The elements to be digitalised to increase efficiency must be selected. In the case of telemedicine, it is primary care that may be more feasible in a remote manner, but in specialty care, for example, the online evaluation

of radiological findings already works. In addition, performing a remote ultrasound examination or ECG examination may also become possible in the future.

Summarising the presentations and roundtable discussions, it can be established that digitalisation is a key element of Hungary's competitiveness and long-term development. The winners of this megatrend will mostly be those who are able to adapt efficiently to the changing circumstances, whether it is a new business model, the use of ERP systems, online meetings or systematised use of digital education tools. The coronavirus crisis brought about not only negative but also positive developments. In the case of the latter we must strive to continue to use the digital tools that seem to work well, both in the case of new ERP and management practices on the businesses' side as well as in the case of time-consuming activities replaced on the users' side. The lesson to be learnt is that digital solutions provide an increase in efficiency in practically all areas, but attention must be paid to selecting the right elements of processes for digitalisation, taking note of the reasonable constraints and the preservation of social relations, because this is what can ensure balance and sustainability.

The roundtable discussions of the FinTech and Financial Culture Section of the HEA were held under the titles of *FinTech upon the explosion of digitalisation* and *FinTech at the time of the coronavirus: challenge or opportunity?* The introductory presentation of the former roundtable discussion was held by *Anikó Szombati*, Executive Director for Digitalisation and the Development of the FinTech Sector of the Magyar Nemzeti Bank, the central bank's Chief Digital Officer. The topic covered the challenges experienced at present in the area of FinTech and digitalisation. In the speaker's opinion, the opportunities of the users of domestic financial services in terms of digital services rank in the middle in the region, which could be a suitable starting point for future development. The pandemic and the related uncertainty, which has appeared in the market of financial services as well, were also mentioned. The business models of banks and insurance companies became exposed to significant pressure, and their prospects in terms of earnings power changed drastically. In her opinion, the number of digitally available services is expected to increase further, and since the majority would like to manage their finances digitally in the near future, more use of artificial intelligence, more platform-based services as well as more streamlined and more agile institutions are needed. Closing her presentation, she said that the MNB had recognised the current trends of digitalisation in due time: the MNB Innovation Hub and Regulatory Sandbox have already been working since 2018. These two digital platforms facilitate the earliest and safest possible entry of new concepts to the market for both FinTech projects and incumbents. In addition, one year ago the MNB published its two-year action plan entitled FinTech Strategy, which determines the central bank's vision and

strategic objectives to support the spread of digitalisation and innovative solutions in the market as much as possible.

Participants in the roundtable discussion entitled *FinTech upon the explosion of digitalisation* were: *Endre Eölyüs*, Director of Mastercard Hungary, *Levente Kovács*, Secretary General of the Hungarian Banking Association, Head of Department at the University of Miskolc and Vice-President of the FinTech and Financial Culture Section of the HEA, *Péter Magyar*, CEO of the Student Loan Centre, *Zsolt Selmeczi-Kovács*, CEO of GIRO Zrt. and *Elemér Terták*, Chairman of the Supervisory Board of K&H Bank, former Director of the Directorate-General for the Internal Market and Services of the European Commission. The discussion was moderated by *Éva Pintér*, Associate Professor, Strategic Leader of the Corvinus FinTech Center and President of the FinTech and Financial Culture Section of the HEA.

The opinions related to FinTech constituted the first topic. The FinTech issue can be approached from various angles. Firstly, it can be defined based on three criteria: (i) simplification of financial transactions, (ii) financial services that become physically more available and cheaper and (iii) the creation of new business models and undertakings, but this sphere of concepts can be approached from the stakeholder side as well: from corporate, customer and regulatory sides. Based on another approach, FinTech is not just a financial technology, but a structure of different financial services and technology that eventually results in customer experience, which is a significant competitiveness factor at the same time. It was mentioned that while speed and customer experience are emphasised in the case of FinTech, society still considers the banking sector a conservative and slowly changing industry, where safety is particularly important. Presumably, the 'FinTechs will deprive banks of their livelihood' period has come to an end; life has proven that they are probably unable to do that, but they may help a lot in complementing complex bank services, and this may be sustained over the long term. This is well reflected by the fact that in addition to its traditional bank counterparts, more and more FinTech firms are contacting GIRO, which operates the Interbank Clearing System, for validation purposes.

Teaching financial awareness as a compulsory subject in primary and secondary schools was mentioned as a crucial factor, and also as deficiency. Participants considered the Money Compass Foundation established by the MNB, the Banking Association and the Student Loan Centre to be a successful initiative, but they argued that the reach of the Foundation is not yet sufficient at national level. If we would like to help society bring up good entrepreneurs or people who are successful both in their respective professions and lives, there is an extremely high need for basic financial awareness. While many teaching subjects are needed by no more than a few per cent of people later in their lives, sensible use of finances is important for everybody, yet it is still not taught extensively. The increasing success

of student loans and the decline in prejudices related to them were also discussed. The participants believe there is great potential in the product; as of next April, vocational training and adult education will also be included in the system up to the age of 55 years. In addition, steps necessary for the financial involvement of the older age group and the catch-up of more remote areas were also discussed, since the market will obviously not open up for them automatically.

Finally, the innovativity of Hungarian banks and expected trends were discussed. Many participants expect an increase in the digital gap, especially in the case of SMEs, where there is no real capacity or motivation to adapt the possibilities provided by digitalisation, and therefore competitiveness concerns were also expressed. The positive experiences of the instant payment system and proposals concerning mobile payment solutions were also outlined. Infrastructure operators, banks and other actors in the financial sector should jointly develop a platform to avoid fragmented ecosystems. International examples show that one country can afford one or two common platforms. According to multiple opinions, extending the ecosystem towards SMEs will only be successful if – in addition to the system providing a uniform solution and *work-flow* simplification – the transactions are implemented together with invoicing. In connection with future payments, safety issues were also discussed: where will the point be where control and safety are worth a few additional seconds for the consumer. Consensus was also reached that the introduction of the pay request service will provide numerous new opportunities for a wider market segment. Finally, it was mentioned that people are generally unaware that neither cash payments nor payments by cash transfer order are free of charge. The social cost of the former is extremely high, while in the case of the latter, this fee is included in the price of the service; so much more efficient and significantly cheaper solutions will be needed in the future.

The introductory presentation of the second panel was held by *Éva Pintér*, who outlined the development of financial innovation and the five pillars of the FinTech ecosystem. The participants in the subsequent roundtable discussion were: *Balázs Barna*, Head of European Expansion at TransferWise, *László Harmati*, Deputy CEO of Erste Bank Hungary Zrt., *István Huszár*, Chief Operating Officer at Bankmonitor.hu, and *Krisztián Kurtisz*, CEO of UNIQA Biztosító Zrt. and Managing Director of Cherrisk. The discussion was moderated by *Péter Fáykiss*, Director of MNB's Digitalization Directorate.

The first topic of the discussion was about the exploitation from the FinTech side of the opportunities provided by the pandemic, with special regard to their faster and more agile abilities to react. Since many people in the spring suddenly needed financial services that did not require going into a bank branch, the demand for digitalisation increased accordingly. Parallel to the customer-side increase perceived everywhere, the pace of bank digitalisation accelerated too: there was a financial

institution that carried out digitalisation development of two years in two months. Another positive development is that not only banks but also regulators were able to follow the significant rise in demand on the customer side. In the participants' opinion, the challenges of the past period were not always more favourable for a rapidly growing FinTech company; for example, an incumbent starts with an advantage during complaints management. As an extreme example, the popular American FinTech brokerage firm Robinhood was mentioned, where many clients lost their money in March because the application became unavailable due to the sudden manifold increase in turnover. By contrast, there was a Hungarian bank whose chatbot provider was even able to handle turnover that quadrupled in a day without any problems.

Thereafter, *Péter Fáykiss* asked the participants in the panel about the developments triggered by the crisis situation, whether the achievements are in line with the resources spent, and whether they would take on their implementation again. The answers revealed that this period has taught banks many things: within record time they managed to digitalise processes that had exclusively been physical before, including the notarisation of contracts, which is a key issue among matters arranged at a branch. The situation and the reactions to it directed even more customers to the digital path than expected, mobile payment solutions accelerated extremely rapidly, and the growing ratio of customers banking exclusively from their mobile phones became one of the major trends. The participants agreed that the unusual situation in the spring forced everybody to apply solutions that have determined competition ever since.

Those present also agreed that the pandemic situation made following and measuring the changing needs of own customers particularly important. In connection with insurance it was mentioned that due to the much less frequent customer contacts, an insurance company has only a fraction of the data a bank has. Nevertheless, the repositioning of insurance companies to mobile platforms has started, and thus the number of interactions as well as the quantity and quality of data that can be used may grow considerably. Banks have put major emphasis on data-based operation to date as well, but its importance has undoubtedly increased, for example in the case of the moratorium as well. The opening up of habitual offline customers to digital channels has also shown a clear trend. One of the underlying reasons is the decline in turnover at branches, although initially this turnover was concentrated at the call centres. The *omnichannel* operation provided by incumbents becomes especially valuable under such strong digitalisation pressure because customers do not necessarily know that these are separated channels; for them, of course, the whole process seems to be one unit.

Changes taking place in organisational cohesion and working were also discussed: the pandemic did not result in significant changes in many places, since working

from home and the use of digital channels had already been part of the daily routine. Banks and insurance companies rapidly switched to teleworking, including the entire call centre service. There was a bank that had already created the conditions for teleworking before, and thus they were able to switch over almost seamlessly in the spring; there was a period when they even reached a ratio of 98 per cent. Based on experiences, the availability of teleworking is considered an advantage during recruiting and retaining as well. Nevertheless, physical meetings will preserve their important role in the future too. There are human contacts, such as periodic, personal appraisals, that cannot be substituted by video calls. Therefore, following the temporary swings to the extreme, an efficient but healthy ratio of the two types of keeping contact should be found. The lesson concerning teleworking was that working from home preferences depend on the employee's individual situation, not on the sphere of activity as previously presumed. It was also discussed that a branch network is a basic service provided by banks, and thus branches must be open, even if it may become necessary to apply reduced and flexible opening hours. It was emphasised that efficiency at firms that operate digitally anyway did not really decline even under such circumstances. This is attributable to the selection process, which follows from the philosophy and mission of such firms.

Finally, *Péter Fáykiss* asked the participants about their 2–3-year expectations in the area of financial services; what, in their opinion, are the business segments where meeting in person is still indispensable, but will be digitalised in three years from now. The answers suggested that even where physical meetings remain in some form, they will be available with significant digital support. Supported by tablets, traditional sales and consulting techniques may achieve extraordinary improvements in the areas of customer experience and efficiency. Personalised and data-based consulting will become much more valuable in the so-called '*phigital*'[1] world. Mainly the asset management and savings product groups as well as the more complex credit schemes can be mentioned here, where this trend may be strong. Aggressive competition may take place in the next 2–3 years, which may result in many changes beyond the new economic cycle. According to one opinion, today's teenagers are the ones whose expectations will determine the finances of the future. These aspects primarily originate from social media and e-commerce, and they are much further ahead than traditional financial services. In addition, financial services are always linked to another service, as already seen in China. There, an ecosystem was created where not only all the financial services but practically all other services appear in an integrated manner in one single application. Consequently, a major issue in the future may be whether banks will be able to control these sales channels.

[1] *Phigital* in this case means partly digital and partly physical, but paperless solutions.

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.
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