Banking Sector Exposures to Climate Risks – Overview of Transition Risks in the Hungarian Corporate Loan Portfolio*

Renátó Ritter

Risks arising from climate change can have a serious impact on the operation of the financial system. In this study, the credit exposures of banks and bank branches operating in Hungary are assessed using two methodologies. To put the results of the analysis into context, they are compared with the results of the survey conducted by the European Banking Authority using the same methodologies. Based on both methodologies, Hungarian institutions may be exposed to the negative effects of climate change at a higher rate than their counterparts in the European Union. Using the two methods together, risk groups were formed, on the basis of which 1.2 per cent of Hungarian institutions were classified in the upper quartile and more than 55 per cent of the banking system was classified in the upper-middle quartile. The methods presented can help not only assess the banking system's transition exposures at the systemic level, they can also be used to assess corporate credit exposures at the institutional level.

Journal of Economic Literature (JEL) codes: C81, G21, Q54

Keywords: climate change, transition risk, sectoral exposure, greenhouse gas intensity

1. Introduction

Climate change is certain to have an impact on countries' economic performance. As some of the most important economic players, banks deserve special attention, and their financing activities have a serious indirect impact on the state of the environment. In particular, institutions may be exposed to two types of risk arising from climate change: transition risks and physical risks (*PRA 2015*).[1]

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

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[1] As a third type of risk, the Prudential Regulation Authority (PRA) in the UK highlighted liability risk for insurers.

Transition risks are risks that threaten market actors during the transition to a carbon-neutral economic structure. The Task Force on Climate-related Financial Disclosures (TCFD) of the Financial Stability Board assigns transition risks to the following four main categories: (i) policy and legal risks, such as the negative economic effects resulting from more stringent policy measures due to climate change (e.g. carbon taxation, phasing-out of carbon-based energy production); (ii) technology risks, which include shocks resulting from technological shifts (e.g. phasing-out of cars equipped with combustion engines); (iii) market risks, which can be understood as negative effects due to changes in preferences (e.g. investors excluding brown assets from their portfolios or consumers shifting preference to sustainably-produced goods); (iv) reputational risks, i.e. a negative shift in the perception of a given economic operator and the resulting economic disadvantage (e.g. share price declines due to an operator's behaviour and its perception) (*TCFD 2020*). Physical risks are subdivided into two types by the TCFD: (i) acute weather events (e.g. floods, forest fires) and (ii) chronic risks (sea levels, temperature rise). Authorities supervising financial institutions increasingly focus on quantifying the effects of climate change on the stability of the economy. The motivation of the study was to assess the extent of the transition risks accumulated in the balance sheets of Hungarian credit institutions in such a manner that the results would be comparable with the surveys of other authorities, in particular the European Banking Authority (EBA). Consequently, for the purposes of this analysis, internationally applied methodologies are used.

The study is structured as follows: *Section 2* assesses the transition exposures of the Hungarian banking system based on the Climate Policy Relevant Sectors (CPRS) approach (*Battiston et al. 2017*). In *Section 3*, based on the EBA methodology, Hungarian corporate credit exposures are classified into greenhouse gas (GHG) intensity groups at the debtor level (*EBA 2021*). In *Section 4*, the results of the two methodologies are compared and the relevant policy steps and proposals that have emerged to date are presented, and in *Section 5*, the conclusions are discussed along with an outline of the implications for improvements.

2. Assessment of transition risks using the CPRS approach

2.1. Data set used

In my analysis, I used stock data for the end of 2021 Q2 and relied on credit data from reporting under Magyar Nemzeti Bank (the central bank of Hungary, MNB) Decree No. 35/2018. (XI. 13.)[2] (HITREG). In the analysis, I included all credit institutions, branches of credit institutions and specialised credit institutions operating in Hungary, whereby exposures were analysed for the credit portfolio of a total of 32 institutions. The analysis is limited to credit exposures to non-financial corporations incorporated in Hungary and non-profit institutions serving households. The exposure amounts were generated on the basis of the principal balance field in HITREG. The principal balance of the overall corporate credit exposure amounted to HUF 9,492 billion, i.e. 96 per cent of the corporate loan portfolio registered by the MNB. The difference may be explained by the exclusion of self-employed entities from the analysis. The EBA conducted its own survey based on the exposures of 29 European banks at the end of 2019, which included only loans to large companies operating in Europe. In its analysis, the EBA used the total original exposure values from the COREP[3] reports, which amounted to EUR 2.35 trillion, representing 42 per cent of loans to companies operating in the European Union (EU)[4] (*EBA 2021*). Due to the difference between the portfolios covered by the EBA and this analysis, and to the analytical considerations described below, the results are not exactly compatible with each other, but they provide a good reference point for putting the Hungarian situation into context.

2.2. The CPRS approach

In their 2017 study, *Battiston et al.* set out the approach for potential CPRS to quantify the exposures potentially affected by climate change. Since then, the approach has been adopted by a number of supervisors and financial institutions. The approach can be widely used since it does not require additional information, but is based entirely on the statistical classification standard for economic activities introduced by the EU (*Eurostat 2008*), which combines the general EU classification code for a given economic activity, NACE Rev. 2.[5] Consistent use of NACE Rev. 2 codes provides comparable information to compare the levels of exposure to individual industries across EU countries. In the rest of the study, the term section is used collectively to refer to the corresponding sections (A–T) and divisions (A01–T98).

[2] A Magyar Nemzeti Bank elnökének 35/2018. (XI. 13.) MNB rendelete a jegybanki információs rendszerhez a hitelügyletek egyes adataira vonatkozóan teljesítendő adatszolgáltatási kötelezettségről (Decree No 35/2018. (XI. 13.) MNB decree by the Governor *the Magyar Nemzeti Bank on reporting obligations for the central bank information system in relation to certain credit data*). https://www.mnb.hu/statisztika/informaciok-adatszolgaltatoknak/rendeletek-allasfoglalasok/35-2018-xi-13-mnb-rendelet

[3] The EBA Common Reporting Framework

[4] COREP (Common Reporting Requirements) 07.00.a and 08.01.a.

[5] Nomenclature générale des activités économiques dans les Communautés Européennes

The CPRS approach assumes that sections of the economy whose activities involve higher GHG emissions will be more affected by regulatory action to mitigate climate change than their counterparts with lower emissions. Based on Eurostat data, the sectors with the largest direct (scope 1 CO_2 equivalent) GHG emissions are identified as a first step, mainly in the sections of utilities, transport, agriculture, manufacturing and households. Furthermore, the CPRS approach specifically names mining, whose direct emissions in scope 1 are relatively low, but, as a supplier to the sections listed above, plays an important role either directly or indirectly (*Battiston et al. 2017*). The classification system also takes into account the classification of so-called carbon leakage risk, which identifies activities (mainly in the manufacturing industry), the competitiveness or costs of which may be strongly affected by carbon control measures, such as the introduction of a carbon tax (*EC 2014*). It is clear that the traditional NACE Rev. 2 classification standard is difficult to use from a climate policy perspective, due to the inadequately homogeneous allocation of activities in terms of climate regulation. For example, in the section of mining and quarrying, there are activities which are expected to be subject to less serious policy action than their counterparts in the same section (e.g. iron ore mining will be less climate policy relevant than hard coal mining registered in the same section), while in manufacturing there are activities (e.g. petroleum refining) which will be highly climate policy relevant in comparison with other activities (*Battiston et al. 2017*). Attention must also be paid to the fact that specifically green activities are not categorised separately in the standard system, such as renewable solar power plants operating in the energy supply sector as coal power plants.

All of the economic activities considered fall into three categories: (i) fossil fuel supplier, (ii) electricity supplier, and (iii) fossil fuel user or electricity user. The third group can be further divided into the traditional policy areas of transport, accommodation and manufacturing. While the supply side of fossil fuels will be most affected by regulatory action to reduce GHG emissions, it can also have a positive and negative impact on other categories, depending on the energy source (fossil or renewable energy). Based on the above, all economic activities can be categorised into *climate policy relevant sectors* or other sectors based on the classification of NACE Rev. 2 level 4.[6] Under the approach, corporate exposures are classified into the following sectors: (1) fossil fuel, (2) utilities, (3) energy intensive, (4) housing, (5) transport, (6) agriculture, (7) finance, (8) scientific research and development, and (9) other. Of these, sectors 1 to 6 are deemed to be involve increased exposure to transition risk and are collectively referred to CPRS 1–6 exposures in the remainder of the study. Under the approach, sectors marked 7 to 9 do not carry transition risks.

[6] https://www.finexus.uzh.ch/en/projects/CPRS.html

Based on the above, the strength of the approach is that it is based on generally available data (NACE Rev. 2 classification), the exposures can be fully assessed (all sectors pertaining to economic activities), and the bank exposures are classified into manageable categories, so that easily understandable results are obtained. The disadvantage of the approach is that it inaccurately assesses companies operating multiple businesses in different sections, since the NACE Rev. 2 classification reflects only the main activity of the company, and the main activity is often incorrectly defined, or the classification simply becomes obsolete and fails to follow the changes in the life of the company. Another disadvantage is that rather than quantifying the risks arising from climate change, the approach merely identifies the exposures concentrated in each sector. As I mentioned earlier, the approach may misclassify activities into groups that are highly exposed to transition risks, even though the activity in question may support the green transition. One example is renewable energy production in the energy supply sector, which is a large GHG-emitting sector in general.

2.3. CPRS exposures in the Hungarian banking system

When analysing the corporate loan portfolio of the domestic banking system, it is useful to first examine the level of exposures to industries before turning to the exposure values reflected in the CPRS approach. When looking at the distribution of sectoral exposures, *Table 1* shows that there are areas in which the banking system has a significant credit exposure, such as manufacturing, real estate, trade and vehicle repair, in which 61 per cent of corporate credit exposures are concentrated.

Table 1
Exposure values and distribution by sector

Sections	Exposure value (HUF billions)	Distribution of exposure (%)
A – Agriculture, forestry, fishing (agriculture)	457.20	4.82
B – Mining and quarrying	8.08	0.09
C – Manufacturing	2,198.48	23.16
D – Electricity, gas, steam and air conditioning supply (energy supply)	327.49	3.45
E – Water supply; sewerage, waste management and remediation activities (water and waste management)	41.41	0.44
F – Construction	570.93	6.02
G – Wholesale and retail trade; repair of motor vehicles and motorcycles	1,648.45	17.37
H – Transportation and storage	563.10	5.93
I – Accommodation and food service activities	315.25	3.32
J – Information and communication	208.05	2.19
K – Financial and insurance activities	17.72	0.19
L – Real estate activities	1,971.50	20.77
M – Professional, scientific and technical activities	730.59	7.70
N – Administrative and support service activities	294.90	3.11
O – Public administration and defence, compulsory social security	0.20	0.00
P – Education	12.62	0.13
Q – Human health and social work activities	55.18	0.58
R – Arts, entertainment and recreation	35.80	0.38
S – Other service activities	34.86	0.37

Source: MNB

The analysis only includes the credit exposures of domestic companies that are assigned to a NACE Rev. 2 classified, so that the CPRS exposure values can be generated for the entire corporate loan portfolio analysed. The database does not include traditional small-scale producers and self-employed entities, which are registered as retail loans, and the analysis also did not include the transaction risks in loans to foreign companies.

After completing the CPRS classification of domestic credit exposures, almost 61 per cent of the exposures of the banking system were classified as highly exposed to transition risks, which is higher overall than the results of the survey conducted by *EBA* (*2021*). The EBA analysis identified 58 per cent of the bank credit exposures to large companies operating in Europe as CPRS 1–6 exposures. In Hungary, the

CPRS 1–6 exposures are mainly accounted for by real estate activities (34 per cent) and manufacturing (23 per cent), as opposed to the EBA survey, in which real estate activities are less strongly represented in the CPRS 1–6 exposures (22 per cent). The EBA results do not specifically identify the CPRS 1–6 share of agriculture (it is included in other categories); however, in Hungary it carries more weight in proportion to these loans, and thus I considered it appropriate to include it in the list (*Table 2*).

Table 2
Distribution of CPRS 1–6 exposures across national economy sectors

Section	Distribution of exposures in Hungary (%)	Distribution of exposures in the European Union (%)
A – Agriculture	8	N/A
C – Manufacturing	23	34
D – Energy supply	6	13
F – Construction	8	10
H – Transportation and storage	9	9
L – Real estate activities	34	22
Other	13	12

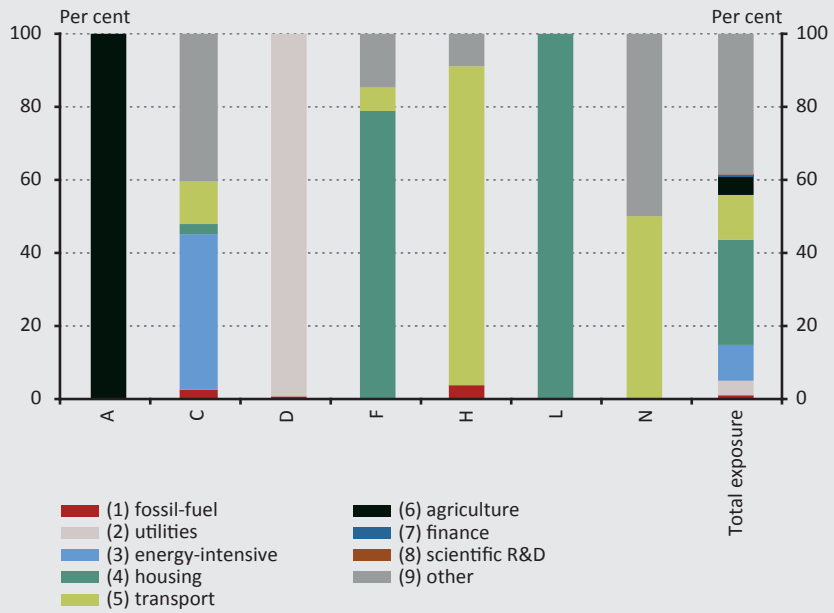
Source: MNB, EBA (2021)

Based on the CPRSs that can be identified in each section, we can obtain information on which specific sectoral regulations may have a stronger impact on the performance of companies operating in that section. From *Figure 1*, it is apparent that some sections are considered completely homogeneous based on the classification of climate policy relevant sectors, i.e. in the event of more stringent policy measures, some sections may become more risky in their entirety. Not surprisingly, agriculture as a whole was identified as the agricultural sector under the approach, the situation being similar in the case of real estate activities – housing sector. A good example of more stringent policy measures is the emergence of new agricultural regulations, the greening of the EU's Common Agricultural Policy,[7] the transition efforts of which (perceived by many as insufficient) can reduce the profitability of the entire group of companies engaged in agricultural activity and indirectly increase the value-at-risk in the loans granted here.

[7] Frost, R. (2021): *CAP: What is the EU's Common Agricultural Policy and why is it trending?* Euronews, 26 November. https://www.euronews.com/green/2021/11/26/cap-what-is-the-eu-s-common-agricultural-policy-and-why-is-it-trending. Downloaded: 8 February 2022.

Not altogether surprisingly, manufacturing is found to be the most heterogeneous section, with the widest variations in the activities of individual companies. Due to the high presence of the 'other' category, this section is not so severely affected by increasingly stringent policy measures in specific CPRSs; therefore, under the CPRS approach a significant part of the manufacturing industry (40 per cent) is not climate policy relevant. While the value for the administrative and support service activities section may be surprising, it also includes machinery rental and leasing activities, which may be affected by transition risks.

Figure 1
Distribution of sections with the highest CPRS 1–6 exposures by CPRS



Note: The figure only covers sections with high CPRS 1–6 exposures. For less exposed sections, exposures were predominantly identified as other sectors. A – Agriculture, forestry, fishing; C – Manufacturing; D – Electricity, gas, steam and air conditioning supply; F – Construction; H – Transportation and storage; L – Real estate activities; N – Administrative and support service activities.

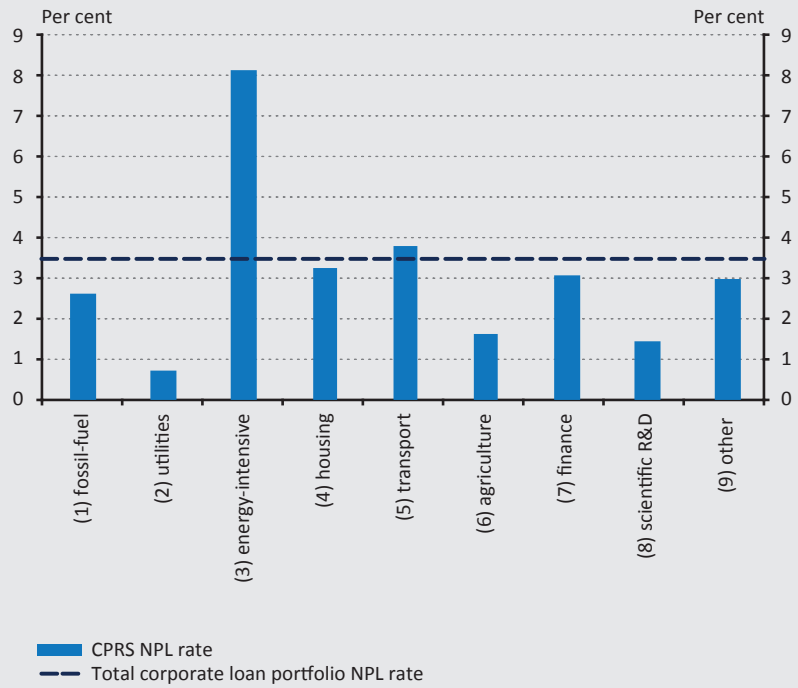
Source: MNB

It is also worth mentioning the different NPL ratios of each CPRS. The ratio of non-performing loans to total credit exposure (NPL ratio), as defined in Articles 5 and 6 of MNB Decree 39/2016,[8] varies by CPRS, which may indicate the resistance of each sector to regulatory shocks. Sectors with already higher-than-average NPL ratios are likely to exhibit a less favourable response to more stringent policy measures (*Figure 2*).

[8] https://net.jogtar.hu/jogszabaly?docid=a1600039.mnb

The average NPL ratio of the total corporate credit exposure is 3.49 per cent, with higher NPL ratios in the energy-intensive and transport sectors (respectively 8.20 and 3.79 per cent). These exposures account for 22 per cent of the total corporate credit exposure. Almost 61 per cent of non-performing exposures were identified as CPRS 1–6 exposures, similar to the EBA's results (60 per cent).

Figure 2
NPL variations across CPRSs



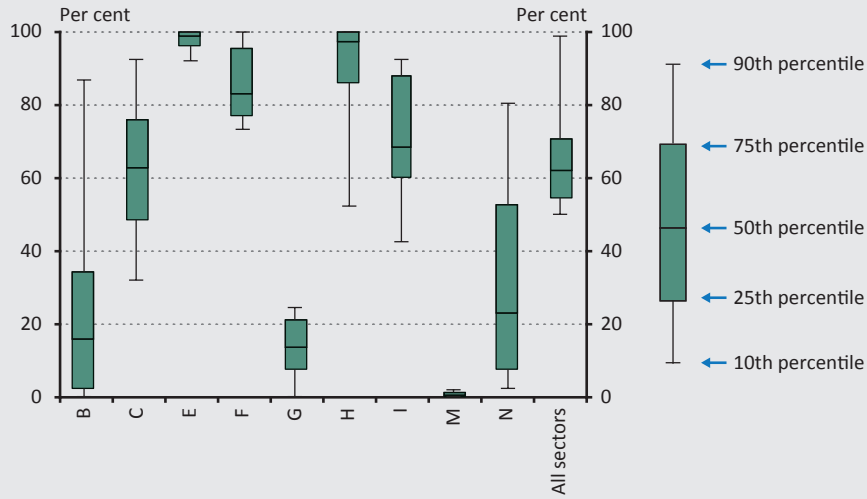
Source: MNB

As mentioned earlier, sections of the national economy show varying levels of relevance to climate policy. In order to quantify this, the CPRS exposure of each bank within the section was examined in relation to its total exposure to the section. *Figure 3* shows the distribution of credit institutions' CPRS ratios by section, which can be interpreted as the exposures of each institution to sections being classified as CPRS 1–6 or CPRS 'other', so that the section value of each institution varies between 0 and 100 per cent, where 100 per cent means that the total exposure to the section qualifies as CPRS 1–6 exposure. *Section 3* shows the section values

of the institutions, i.e. how individual institutions' CPRS 1–6 and CPRS 'other' exposures are distributed in each sector. One-quarter of the data falls below the 25th percentile, and three-quarters above. The 75th percentile halves the upper part of the data, with three-quarters of the data below it, and one-quarter of the data above. The 50th percentile is the median for the data. In the figures, only the values between the 10th and 90th percentiles are indicated, in order to eliminate the outliers, and small banking portfolios were omitted from the analysis (section exposures below HUF 100 million), which would also distort the meaning of the figure by showing accumulated risks even where the exposures at hand are not significant. *Figure 4* and *5* below are also to be interpreted as above.

Several institutions have accumulated significant CPRS exposures in certain sections. For one-half of the banks, more than 60 per cent of exposures to manufacturing, water and waste management, construction, transportation and storage, and accommodation and food service sections qualify as CPRS exposures (*Figure 3*). This means that potentially upwards of 60 per cent of the section portfolio of specific banks could be affected by more stringent policy measures in the section, which would affect the creditworthiness of their debtors operating in the section. The most important indicator in this respect is the proportion of CPRS exposures in each banking portfolio across all sections. For one-half of the banks, more than 62 per cent of their exposures were identified as CPRS exposures, while 10 per cent of the institutions had nearly all of their exposures (99 per cent) financing climate policy relevant sectors. This is mainly due to the exposures of small institutions, mortgage banks to the section of real estate activities. In the EBA survey, EU institutions had a higher CPRS concentration per section, with one-half of the banks having more than 70 per cent of their exposure financing CPRS exposures in the manufacturing, water and waste management, construction and transportation and storage sections. Both surveys identified 100 per cent of exposures to agriculture and energy, and nearly 100 per cent of exposures to real estate activities as CPRS exposures.

Figure 3
Banks' CPRS exposures by national economy section

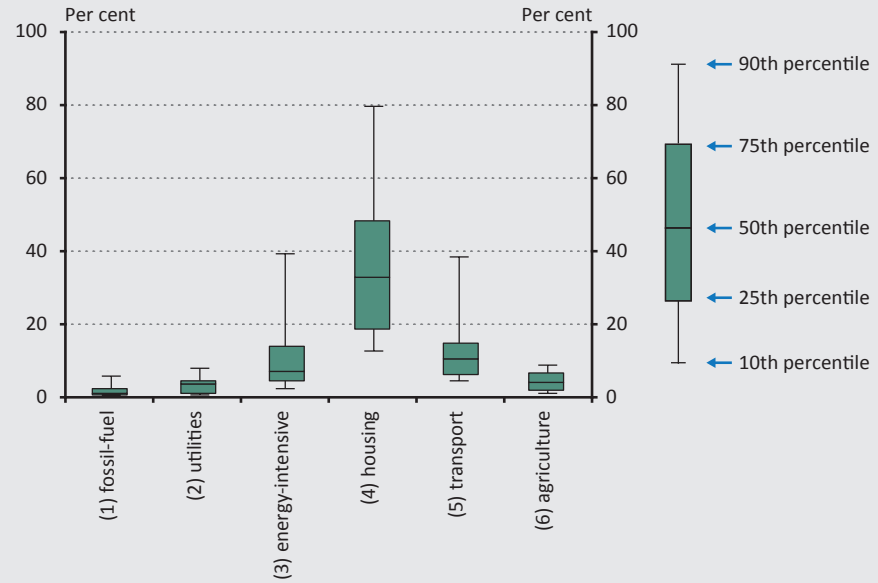


Note: B – Mining and quarrying; C – Manufacturing; E – Water supply; sewerage, waste management and remediation activities; F – Construction; G – Wholesale and retail trade; repair of motor vehicles and motorcycles; H – Transportation and storage; I – Accommodation and food service activities; M – Professional, scientific and technical activities; N – Administrative and support service activities.

Source: MNB

At some banks, a major proportion of the exposures are concentrated in specific climate policy relevant sectors (*Figure 4*). The percentage of the total corporate portfolios of individual institutions that is used to finance specific CPRSs was also examined. The highest concentration of bank exposures was found in the housing sector, where one-half of the institutions report more than 32 per cent of the exposures financing the sectors; but this is also where the largest outliers are found. One small institution is fully exposed to the housing sector, which may pose a serious risk to its stability. There are lower concentrations in other sectors, but the median value of the energy-intensive and transport sectors (7 and 10 per cent, respectively) is still noteworthy.

Figure 4
Bank exposures to CPRSs



Source: MNB

3. Assessment of banks' GHG risk based on the EBA's methodology

While no uniform methodology for measuring the carbon risks to banks' portfolios has been adopted so far, several calculation methods have already been defined to quantify these risks. One common feature in those methods is the use of GHG intensity, which shows the amount of GHG emissions associated with one euro of added value. European Union countries' intensity data are compiled by Eurostat comprehensively for sections (NACE Rev. 2 Level 1: A-T) and not comprehensively for divisions (NACE Rev. 2 Level 2: A01–T98) (*Bokor 2021*). As the data are updated with a lag of two to three years, the most recently available actual data on intensity from 2018 were used in the analysis, disregarding the estimated values for 2019. The methodology of the MNB's Banking Carbon Risk Index (hereinafter BCRI) published in 2021 (*Bokor 2021*) is also based on this database, which assesses the carbon risk of bank portfolios with two functions, based on the GHG intensity of each economic activity. The two functions capture different interpretations of the risks arising from GHG intensity. As mentioned previously, TCFD (*TCFD 2017a*) defined several indicators to measure the carbon exposure of banking, insurance, fund

management, investment service and fund portfolios, focusing on the weighted average carbon intensity indicator[9] (*TCFD 2017b:43*).

In its analysis, the EBA takes a simpler approach to the quantification of risks arising from the GHG intensity of portfolios compared to the above-mentioned methods: using the available intensity data, it classifies banking exposures into six groups of GHGs: (i) very low, (ii) low, (iii) medium, (iv) medium/high, (v) high and (vi) very high. Corporate exposures are matched on the basis of NACE Rev. 2 Level 2 with their respective GHG exposure values and then assigned to the appropriate group on the basis of criteria derived from GHG intensities (*Table 3*). The EBA also used individual enterprise GHG emissions data (17 per cent of the corporate exposures had individual values) for the purpose of its analysis, resulting in more nuanced group thresholds, as opposed to using only section-level intensity data. For the preparation of this study, no individual company emissions data were available, and thus the grouping was based solely on section-level GHG intensity data. Almost all of the corporate loan portfolios considered for the analysis included available section-level GHG intensity data.

Table 3
Classification of GHG intensity groups and corporate exposures

GHG group	Entry criterion	Exposure amount (HUF billions)	Distribution (%)
Very low	GHG ≤ P10	2,047.23	21.6
Low	P10 < GHG ≤ Q1	1,100.26	11.6
Medium	Q1 < GHG ≤ Median	1,256.91	13.2
Medium/High	Median < GHG ≤ Q3	3,432.86	36.2
High	Q3 < GHG ≤ P90	1,227.90	12.9
Very high	GHG > P90	426.44	4.5

Note: P10 – 10th percentile, Q1 – 1st quartile (25th percentile), Q3 – 3rd quartile (75th percentile), P90 – 90th percentile.
Source: MNB

In Hungary, more than 53 per cent of corporate exposures are used to finance activities above the median GHG intensity, which is significantly higher than the 35 per cent figure obtained by the EBA. The difference can be explained partly by the difference in the GHG intensity data used for grouping (individual vs. section-level). However, it is not surprising that, overall, Hungarian banks show a higher ratio of financing GHG-intensive sectors than their counterparts in the European Union. Although it decreased by 45 per cent between 1995 and 2019 due to the transformation of the country's economic structure and industrial sector, the energy intensity of Hungary's economy (energy consumption per unit of economic output)

[9] Weighted average of Carbon Intensity, WACI

is still almost twice as high as the EU average (*MNB 2021a*). Nevertheless, based on GHG intensity, almost one-half of corporate exposures may be affected, to varying degrees, by transition risks such as the record-high carbon allowance price of EUR 60 at the end of the summer.[10]

Based on the results of the BCRI referred to above, in 2021 Q2 the ratio of the corporate loan portfolio financing exposures considered to be extremely high risk in terms of GHG intensity (*Bokor 2021*) was 8 per cent using a linear function and 15 per cent on the basis of a Gompertz sigmoid function. The index assumes a functional relationship between risks and GHG intensity: thus, the higher the GHG intensity of a given activity, the higher the risk value assigned under the method. In contrast to the linear function, the Gompertz function hardly penalises less GHG-intensive activities, while exposures that are considered to be too polluting at a certain point are fully included in the risk category. The Gompertz result thus obtained corresponds approximately to the amount of credit covered by the high and very high GHG group that I identified. The EBA and the GHG grouping methodology used here classify the respective exposures into GHG intensity groups on the basis of critical values (see the inclusion criterion), and therefore the results are not fully compatible with the results of the BCRI's methodology based on a functional relationship, but both methods yield a similar picture.

In the analysis, I identified several major pollutant national economy sections. 77 per cent of the very high category was accounted for by energy supply, while the remaining part was accounted for by manufacturing (16 per cent) and water and waste management (7 per cent). More than 27 per cent of the high category was made up of manufacturing, while 37 per cent was made up of the agricultural sectors, but high ratios were also found in transportation and storage (20 per cent) and, surprisingly, in administrative and support service activities (15 per cent). The latter belongs in the high category at such a high rate because this section includes the machinery rental and leasing services divisions, which are considered to be activities with a high GHG intensity.

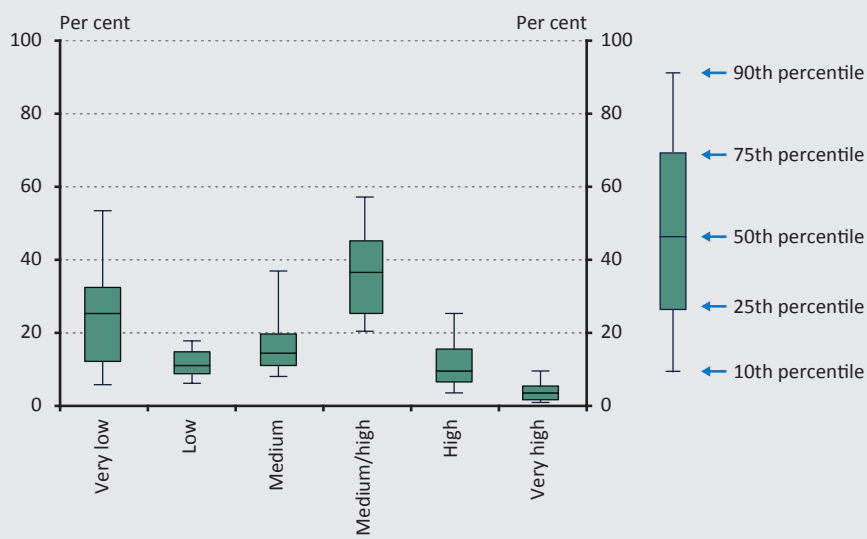
The results are supported by Hungary's GHG emission data. Based on the most recent revised data from the HCSO from 2018, 72 per cent of greenhouse gas emissions came from economic activities.[11] The most polluting energy supply sector accounted for 19 per cent of total emissions. The GHG emissions of the manufacturing industry were strongly affected by the degradation of heavy industry, the modernisation of the chemical industry and the decline in fuel consumption due to the financial crisis in 2009 (*HCSO 2017*). Nevertheless, the second most

[10] Hook, L. (2021): *Carbon price rises above €60 to set new record*. Financial Times, 30 August. https://www.ft.com/content/c1a78427-f3d5-4b4f-9878-c3e1dffee2ba. Downloaded: 22 November 2021.
[11] Annual GHG emissions data are published by the HCSO for Hungary in the form described here. https://www.ksh.hu/stadat_files/kor/hu/kor0018.html. Downloaded: 15 February 2022.

polluting section of the national economy is responsible for about 16 per cent of total emissions in 2018, followed by agriculture at 12 per cent. In terms of GHG emissions, the real estate activities section is strikingly absent, the activity of which is associated with relatively low GHG intensity based on both Eurostat and HCSO data (according to HCSO data, the sector accounted for less than 1 per cent of total emissions in 2018), whereas in practice real estate indirectly accounts for a significant proportion of GHG emissions, as 28 per cent of 2018 GHG emissions can be attributed to households (who obtain homes through real estate), primarily related to heating and car use (the latter not related to real estates).

In the following, I assessed how the exposures of the individual banking portfolios are distributed across GHG intensity groups. Although the proportion of GHG exposures is higher than in the EBA survey, in terms of GHG concentration, the portfolios of Hungarian credit institutions are arguably more diversified than those of their counterparts in the European Union (*Figure 5*). In the EBA survey, half of the banks financed activities with very high GHG intensity with more than 10 per cent of their exposure, while the median value of Hungarian institutions in the same group was only slightly more than 3 per cent. However, it is important to mention the outliers: 10 per cent of Hungarian institutions finance such activities with more than 9 per cent of their exposures, while the most polluting institution has 54 per cent of its exposures in highly polluting activities.

Figure 5
Distribution of bank portfolios across GHG groups



Source: MNB

The median value of the high category exceeds 9 per cent, i.e. the portfolio of one-half of the institutions finances activities with high GHG intensity to an extent exceeding 9 per cent, which is approximately the same as in the EBA results. Institutions with outliers can also be found in the high category, with one institution financing such activities at 41 per cent and another at 34 per cent.

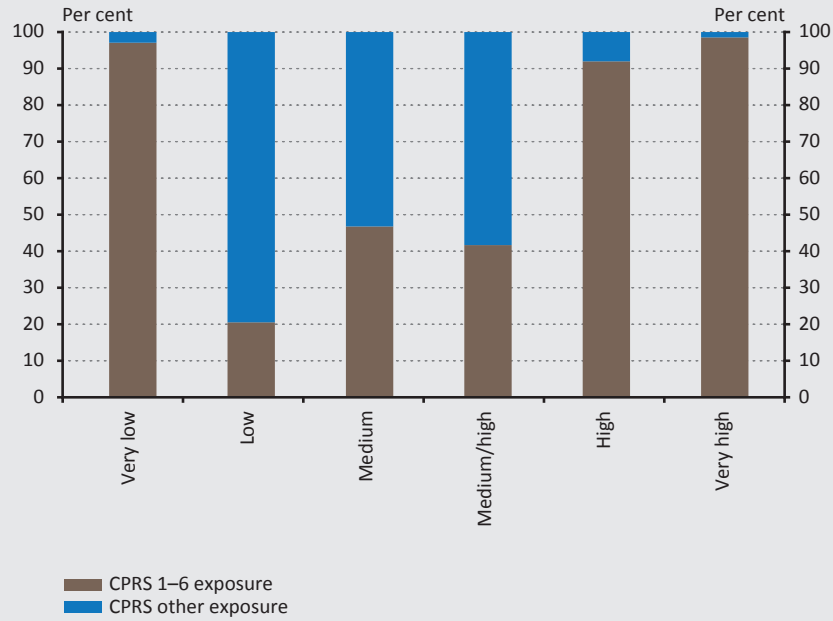
There are large variations in the other GHG intensity groups. The exposures of the Hungarian banking system above the median GHG intensity are concentrated primarily in the medium/high category, and the median value of the category (37 per cent) significantly exceeds the results of the EBA (nearly 20 per cent). It is also important to mention the very low GHG intensity group. As explained earlier, the intensity data for real estate activities are misleadingly low, while the value of bank exposure for these activities is significant (21 per cent of the total corporate exposure), which largely explains the high share of the very low group.

4. Comparison of banks' GHG and CPRS exposures

4.1. Overlaps between the two methodologies

Either of the two methodologies presented so far can, in itself, provide an insight into the exposure of a portfolio to transition risks, but it is worth using the two together in order to avoid ignoring risky activities that are successfully identified by only one of the methods. As we have seen, both methods are capable of assessing highly polluting activities (*Figure 6*), with 98 per cent of the very high GHG group and 92 per cent of the high GHG group identified through the CPRS approach. The agreement is also due to the fact that by design the CPRS approach relies heavily on the data of the average GHG intensity of each economic activity, as mentioned in the description of the approach. The accuracy rate is lower in the medium and medium/high groups, with 47 and 42 per cent of these activities identified as CPRS, respectively. We can see contradictory results for the very low categories, which is mainly attributable to the real estate activities mentioned earlier; although the CPRS approach classifies this section as climate relevant, Eurostat attributes it to a very low GHG intensity. The difference can be explained by the methodology used by Eurostat for the production of GHG data, i.e. the resulting GHG emissions are taken into account where they are actually released into the atmosphere, so that real estate activities have no direct responsibility, but a large degree of indirect responsibility for the emissions that may occur in energy supply (for example, the emissions arising from the heating and electricity supply of homes). Thus it can be concluded that transition risks cannot be fully assessed on the basis of a single methodology: relying solely on GHG data would have resulted in ignoring the transition risk exposure of a very significant section.

Figure 6
Relationship between GHG and CPRS classification



Source: MNB

It is important to reiterate that in its assessment the EBA used specific GHG emissions data, where the CPRS approach followed the GHG groups created based on individual emissions data much more closely. The EBA also identified CPRS exposures in the very low category (nearly 15 per cent), but the option cannot be ruled out that a given company, although classified with an activity exposed to climate change according to its NACE Rev. 2 code, carries out its activity more sustainably and with less emissions than its competitors. It is therefore possible that corporate credit exposures considered to be exposed to transition risks based on their activities may also occur in the lower GHG intensity categories if the individual emissions of the given companies are lower than the section average.

4.2. Identified transition risk groups

In view of the foregoing, it is advisable to start using the results of both methodologies to determine the transition climate risk of an institution. I determined the risk exposure of an institution by placing them in a figure where the X-axis shows the ratio of the bank's exposure value to its total corporate exposure as assessed under the CPRS approach, and the Y-axis shows the share of exposures above the median GHG intensity in the total corporate exposure (*Figure 7*). The resulting risk grid is divided into four blocks, with credit institutions classified

into the following categories: (i) upper quartile, (ii) upper-middle quartile, (iii) lower-middle quartile and (iv) lower quartile (*Table 4*). In the upper quartile, I classified the institutions where at least 75 per cent of each portfolio finances activities exposed to climate change on the basis of both GHG intensity and the CPRS approach; 1.2 per cent of the Hungarian banking system belongs here in terms of balance sheet total. In the next group, I classified institutions where at least 50 per cent of each portfolio finances activities exposed to transition risks under both methodologies; such institutions make up a major part of the Hungarian banking system, with over one-half (55 per cent) of the institutions belonging in this category.

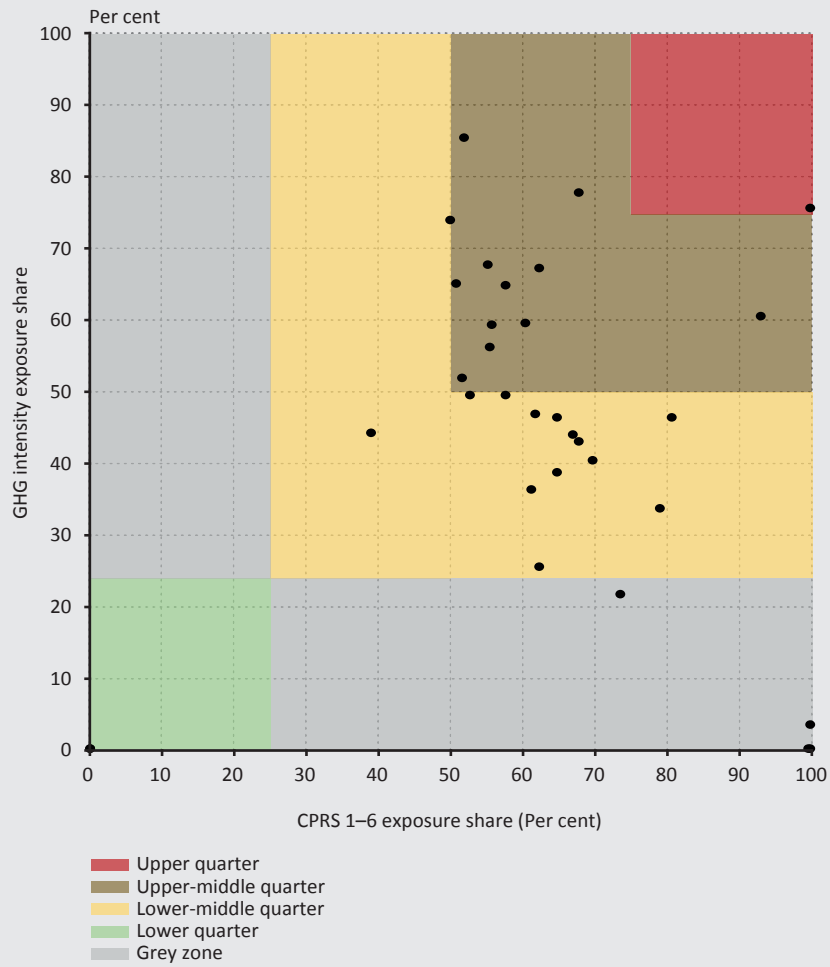
Table 4
Transition risk groups identified in the Hungarian banking system

Group	Threshold	Distribution of the banking system (by corporate credit exposure, %)	Distribution of the banking system (by balance sheet total, %)
Upper quartile	CPRS 1–6 exposures and GHG exposures above the median >= 75%	0.00	1.20
Upper-middle quartile	CPRS 1–6 exposures and GHG exposures above the median >= 50%	49.00	55.10
Lower-middle quartile	CPRS 1–6 exposures and GHG exposures above the median >= 25%	50.30	39.70
Lower quartile	CPRS 1–6 exposures and GHG exposures above the median < 25%	0.00	1.30
Grey zone	At least one of CPRS 1–6 exposures and GHG exposures above the median > 25%	0.60	2.70

Source: MNB

I construed the grey zone as comprising the two cases where only one of the two methodologies will capture transition risk. In this category, it may be appropriate to carry out further studies on the portfolios of the relevant institutions; for example, in this group, it would be really important to carry out the survey on the basis of individual GHG data. This may be relevant to 2.7 per cent of the Hungarian banking system. Finally, I identified a group with low climate risk exposures, whose exposures finance less than 25 per cent of activities exposed to transition risks based on both methodologies, which is 1.3 per cent of the Hungarian banking system.

Figure 7
Climate risk grid of the Hungarian banking system



Source: MNB

4.3. Policy actions to date and their outcome

In the light of the results, it is not surprising that the MNB has launched a corporate and municipal capital requirement reduction programme from 2021 onwards in order to mitigate climate risk in the institutions' portfolios (*MNB 2020*). The programme, which was expanded in the summer of 2021 (*MNB 2021b*), covers not only renewable energy production as announced initially, but also green corporate credit exposures related to electromobility, sustainable agriculture and the food industry, as well as energy efficiency. In assessing the sustainability of exposures, the

MNB relied on the documents established by the EU defining sustainable economic activities, the EU Taxonomy Regulation[12] and its technical annex published to date.[13]

Over the course of six months, 1 per cent of the total corporate loan portfolio was included in the scheme, but this had a significant impact on the operation of two branches of the economy, which were traditionally classified as the largest polluters, as 26 per cent of the credit exposures to Section D – Energy and 21 per cent of the exposures to Section B – Mining and quarrying were included. If the green loans submitted as part of the MNB's green capital requirement reduction scheme are taken into account when determining the risk exposures, the CPRS 1–6 of the total corporate credit exposure decreases from 61 per cent to 60 per cent as described above. The combination of the ratio of green loans and the reduction in CPRS confirms that the scheme has well defined the range of transactions to be supported.

With the expansion of the scheme, the greening of other economic sections can be expected at a similar pace. In addition to the introduction of incentives, the MNB also seeks to draw the attention of credit institutions to the importance of the risks arising from climate change as quickly as possible. In the first half of 2021, the MNB issued a Green Recommendation to the sector, in which it "*sets expectations regarding the management of climate change and environmental risks, as well as the enforcement of environmental sustainability aspects in the business activities of banks*" (*MNB 2021c*).

4.4. Proposal for credit institutions

The methodology outlined earlier may not only be suitable for assessing the risk of the corporate loan portfolio of the entire banking system, but may also be used for assessing the transition risks inherent in corporate loans at the institutional level. The institution can use the two methods to assess which of its debtors are identified as risky under the CPRS approach based on the GHG intensity and which debtors are identified as risky under both methodologies (or neither). The advantage of the method is that it is a simpler, easy-to-implement method of analysis compared to the tools available so far, complete with a table of correspondence[14] for CPRS classification (*Battiston et al. 2017*), and annually updated Eurostat GHG intensity data,[15] which – in the absence of individual emissions data – can be used to calculate GHG groups.

[12] *Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020R0852&from=EN. Downloaded: 15 November 2021.

[13] *Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021R2139&from=EN#d1e622-1-1. Downloaded: 15 November 2021.

[14] https://www.finexus.uzh.ch/en/projects/CPRS.html

[15] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_aeint_r2&lang=en

Institutions may also have additional information on the activities of their debtors, such as whether they are operating in multiple sectors or have a corporate climate adaptation strategy, thus clarifying the results of the baseline classification.

4.5. Implications for improvements

The analysis can be improved from a number of perspectives. By expanding the range of exposures, we can obtain a more accurate picture of the accumulated climate exposures in institutions, for example by analysing the exposures arising from securities, in particular corporate bonds, bank-book shares and shares purchased in investment funds. The analysis did not include debt in loans registered as retail exposures to self-employed entities and traditional small-scale producers,[16] who are important for the subject, nor the potential transition risks in foreign corporate exposures, so it may be justified to examine all of these more closely at a later stage. As I noted previously in several instances, the setup of GHG intensity groups on the basis of individual emissions data and judgement of debtors on the basis of their individual emissions data would greatly contribute to the accuracy of the analysis. When determining the risk exposures, more attention could be paid to the green loans submitted as part of the MNB's green capital requirement reduction scheme. While under the CPRS approach manual reclassification is viable (the aggregate effect of which is described above), in the case of GHG intensity groups, in the absence of individual emissions data, it is not clear which group the known green transactions should be classified into. As regards the analysis as a whole, I have largely relied on the NACE Rev. 2 classification, which is the main activity of the companies and which, as mentioned above, can often mislead the analysis. The accuracy of the analysis would be greatly enhanced if the actual principal activity of the companies were recorded separately in HITREG, and would also be greatly clarified if the activities financed by each loan were identified. The distribution of the revenue data of individual companies according to NACE Rev. 2 would also greatly clarify the results if the database of the National Tax and Customs Administration of Hungary included these data.

The classification results of exposures may provide good input data for the stress testing of institutions, as already used in CPRS classifications by *Battiston et al.* (*2017*) and *Roncoroni et al.* (*2021*). A steadily growing number of central bank climate stress test exercises (*Vermeulen et al. 2018*; *Muñoz et al. 2021*; *MNB 2021d*) have sought to quantify the financial risks arising from climate change, which may be relevant for a more accurate grasp of the various diversions of exposures identified on the basis of the methodologies presented above in the context of different scenarios and assumptions.

[16] With both small-scale producers and self-employed entities, the problem was that they were registered as retail loans rather than corporate loans, whereby including this data set would have made it very difficult to carry out the analysis.

5. Summary

At the beginning of the study, I laid down the conceptual framework, defining the risks arising from climate change and then presented the data set used in the analysis. The analysis was based on data from 2021 Q2, covering corporate credit exposure totalling HUF 9,492 billion. After presenting the theoretical background to the CPRS approach, I assessed the Hungarian corporate exposures of credit institutions operating in Hungary, first examining the exposure of individual sections to transition risks and then the extent of transition risks built up in individual banks, and compared the results with the results of the research carried out by the EBA. According to the analysis, 61 per cent of the exposures examined were classified as highly exposed to transition risks, which is overall higher than the 58 per cent measured by the EBA, but there was a higher concentration in the institutional portfolios, and half of the institutions financed activities exposed to transition risks to a greater extent than 62 per cent. According to the results measured on the basis of the GHG intensity methodology, the institutions operating in Hungary financed activities above the median GHG intensity to a greater extent than their counterparts in the European Union, and compared to the 35 per cent measured by the EBA, nearly 54 per cent of corporate exposures in Hungary are financing such activities. However, contrary to the results of the CPRS approach, it can be stated that no clearly large polluting institutions can be identified in Hungary compared to the European Union banks surveyed by the EBA, and the exposures to the transition risks associated with GHG intensity are relatively evenly distributed throughout the banking system.

When the results of the two methodologies are examined together, 5 groups can be defined based on the exposure of the respective institutional portfolios to transition risks. 1.2 per cent of the Hungarian banking system belongs in the upper quartile group, which carries high transition risks under both methodologies, and more than one-half (55 per cent) of the Hungarian banking system belongs to the upper-middle quartile group, involving the second highest level of exposure. A significant part of the banking system falls into the lower-middle quartile, with nearly 40 per cent of the institutions belonging here. Only slightly more than 1 per cent of the institutions belong in the lower quartile, representing the lowest levels of exposure to transition risks. I identified nearly 3 per cent of the institutions as belonging in the grey zone, where more granular data may be required for establishing a more accurate standpoint. Finally, I presented the regulatory steps taken by the MNB on the subject so far, highlighting the results of the green corporate and municipal capital requirements discount, which are also relevant for the study, i.e. the emergence of green corporate loans in traditionally large polluting sections. I have also drawn up an easy-to-implement, low-cost methodology for the institutions to comprehensively assess their transition risks. A future research objective may

be the implementation of the improvements discussed at the end of the study, which would provide a more accurate picture of the risks inherent in the Hungarian banking system. The more accurate the picture we have of the climate risks built up in banks' balance sheets, the easier it is to tackle the economic challenges of climate change at both the regulatory and institutional levels.

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