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Environmental impact of mortgage bond purchases: presentation of a possible estimation methodology

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Abstract

This article presents a methodological framework for estimating the environmental impact of mortgage bond purchases. The model presented through the Mortgage bond purchase programme of the Magyar Nemzeti Bank (MNB), the Central Bank of Hungary builds on the changing composition of the Hungarian housing stock, and its main assumption is that, while maintaining the total floor area of the housing stock unchanged, financing residential property modernises the housing stock as a result of tightening building energy requirements, which reduces emissions. In our estimate, thanks to the MNB's Mortgage bond purchase programme, the Hungarian building stock could reduce its CO_2 emissions by 13-41 thousand tonnes per year. We have made several assumptions and simplifications in our calculations, and the results can only be evaluated in this context.

Keywords

Mortgage bond, environmental impact, building stock, carbon emission

1. Introduction

Today, it is clear that climate change and sustainability are one of the greatest challenges facing humanity. Every day there are news stories about temperature peaks, droughts or even floods caused by climate change. Climate change affects all our lives in different ways and to different degrees. Accordingly, it is also essential to look at how we are influencing climate change and the factors that cause it. Data and various calculations and estimates play an essential role in mapping these. Without data, there are no calculations; without calculations, there is no point in discussing effects.

In this article, we try to estimate the environmental impact of a previous asset purchase programme of the Magyar Nemzeti Bank, the Mortgage bond purchase programme, using a model-based calculation. This paper was inspired by the MNB's Climate-related Financial Disclosure, the TCFD report (MNB, 2022a). We started to address the issue in the context of this report. We believe that, despite the methodology and the estimation difficulties, it can be a useful input for the analysis of other assets or asset purchase programmes, and that is why we have written this article.

In the article, we first briefly review the, mostly technical, literature and the Mortgage bond purchase programme itself. We then present the methodology and the model's logic, assumptions and estimation results. Finally, we summarise our writing.

2. Literature, background

Renewing and financing the renewal of housing stock is a goal for many countries worldwide. Unsurprisingly, the built environment is a major contributor to emissions, accounting for almost half of the annual global CO_2 emissions. Of those total emissions, building operations are responsible for 27% annually.

In 2040 approximately two-thirds of the global building stock will be buildings that exist today, so without improvements, it will continue to burden the environment (Architecture2030, 2022).

Renewing the building stock is also a major challenge in Hungary, where the housing stock is outdated and has poor energy performance (Nagy, T. & Winkler, S., 2021). In this context, 40 per cent of the final energy consumption in Hungary is related to buildings (MNB, 2022b). In their comprehensive study on the Hungarian green bond market, Becsi et al. (2022) also highlight the high share of real estate in emissions and the need for modernisation in Europe and Hungary.

Due to the specific nature of the study, the available literature on the environmental impact of securities is very limited. Generally, we found that one direction of dual materiality, the financial materiality approach, appears in the literature. By dual materiality, we mean the concept that not only does climate change have an impact on companies (and other institutions), but they also have an impact on the climate, as shown in Figure 1:

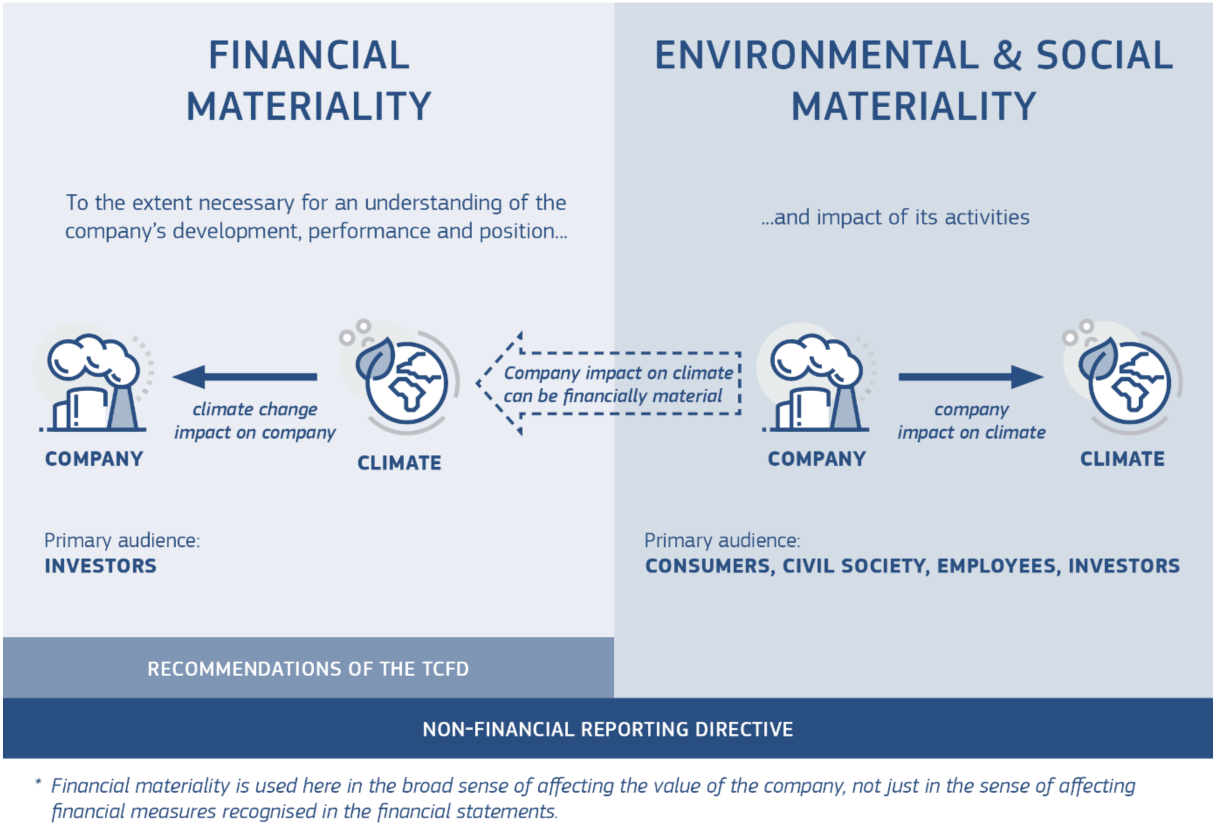

Figure 1. Double materiality

(Source: European Commission, 2019)

There is more literature on the former branch of dual materiality. Climate change's impact on companies and the prices and risks of securities and other financial instruments has been the subject of several studies, and the TCFD reports mentioned above typically follow this logic[1]. *Kolozsi et al. (2022)* conducted a comprehensive study on this topic, analysing TCFD reports from central banks and examining the measurement options and methodological challenges of climate risk regarding financial instruments.

[1] It is important to highlight that the TCFD (Task Force on Climate-Related Financial Disclosures) provides recommendations, so although the reports are similar in structure, they may differ in methodology and depth.

There is much less literature on the other direction of dual materiality, specifically on financial instruments' environmental impact. This and the unavailability of data led us to try a new methodology in this article. However, besides the lack of literature, it is also important to note that environmental impact reports already exist, which, although not considered literature, contain much useful technical information on green mortgage bonds. We also show examples of these for comparison when presenting our results.

3. Brief description of the MNB's Mortgage bond purchase programme

In 2018, the Magyar Nemzeti Bank entered the mortgage bond market as a buyer under a programme, and in 2020, to mitigate the negative economic impact of the coronavirus pandemic, it reintroduced its Mortgage bond purchase programme. These two phases of the programme successfully supported the objectives pursued: domestic mortgage bond issuance increased substantially, and the MNB helped banks to obtain long-term, stable forint funding. Under the programmes, the MNB purchased fixed-rate mortgage bonds denominated in forint from domestic mortgage banks and strongly emphasised participation conditions enhancing transparency.

In the programme's first phase, the MNB made purchases in the primary and secondary markets for HUF 381 billion in nominal value throughout 2018 and HUF 307 billion in nominal value in the second phase, from May 2020 to July 2021. In this article, we show how the environmental impact of mortgage bonds on the central bank's balance sheet can be estimated and the exposure of the MNB.[2]

Mortgage bonds are securities issued against a specific regulatory background. Following Hungarian law, at least 80 per cent of their collateral consists of so-called ordinary assets and the remainder of margin assets. An ordinary asset is a principal amount outstanding from mortgage loans and interest due under the contract [3]. These loans are backed by real estate as collateral, so the mortgage bond purchases indirectly finance the construction, purchase, modernisation and extension of real estate. However, the link between mortgage bond purchases and real estate is indirect, as the common collateral pool does not allow a clear link between the actual transactions financed by the mortgage bonds and the contribution of MNB purchases to these transactions. A further challenge is that, before the emergence of the MNB's green initiatives, banks typically did not collect data on the energy performance and environmental impact of the properties in connection with the real estate transactions, so this data was not available for us. Overall, data scarcity and limited data availability strongly determine the methodology that can be used to estimate the environmental impact of mortgage bond purchases.

4. Description of the methodology (model)

The ultimate aim of the model is to estimate how much CO_2 emission reductions could result from the non-green phases of the MNB's Mortgage bond purchase programme. We try to illustrate this by looking at the change in the composition of the Hungarian housing stock, linking it to total mortgage lending and the MNB's purchases of mortgage bonds.

The model is based on the National Building Energy Performance Strategy published in 2015 (*Ministry of National Development, 2015*). The document presents, among other things, the composition of the Hungarian housing stock in 2013, broken down into 15 types of residential buildings, and also includes the total floor area (m^2) and specific energy consumption ($kWh/m^2/year$). We previously explored other data sources, but this was the only one we found sufficiently reliable and appropriate. We used the following table in our model:

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[2] A new phase of the Programme was later launched, the Green Mortgage Bond Purchase Programme. This programme already introduced reporting requirements, which would allow participating banks to provide their own, presumably more accurate, estimates of the environmental impact of their mortgage bonds. However, the incentive effect of the Green Mortgage Bond Purchase Programme will come later than the period under review, so this phase of the programme was not taken into account.

[3] See more details: Act XXX of 1997 on Mortgage Loan Companies and Mortgage Bonds – https://net.jogtar.hu/jogszabaly?docid=99700030.tv

	Building type	Total floor area (m^2)	Specific primary energy consumption (kWh/m^2a)	Calculated annual energy consumption (kWh)
1.	**family houses below 80 m² before 1945**	15,918,873	551	8,771,299,023
2.	**family houses above 80 m² before 1945**	29,610,378	408	12,081,034,224
3.	**the family house below 80 m² 1946–1980**	25,746,455	517	13,310,917,235
4.	**the family house above 80 m² 1946–1980**	83,997,263	405	34,018,891,515
5.	**family houses 1981–1990**	39,914,396	336	13,411,237,056
6.	**family houses 1991–2000**	23,667,465	227	5,372,514,555
7.	**family or terraced houses (1 to 3 apartments) after 2001**	24,466,147	173	4,232,643,431
8.	**multi-apartment buildings (4 to 9 apartments) before 2000**	17,471,243	312	5,451,027,816
9.	**multi-apartment buildings (4 to 9 apartments) after 2001**	2,929,898	125	366,237,250
10.	**multi-apartment buildings (10 or more apartments) before 1945**	14,066,410	344	4,838,845,040
11.	**multi-apartment buildings (10 or more apartments) 1946–2000**	10,260,214	299	3,067,803,986
12.	**multi-apartment buildings (10 or more apartments)**	11,346,937	244	2,768,652,628
13.	**multi-apartment buildings (10 or more apartments) 1946–1980**	16,174,606	218	3,526,064,108
14.	**multi-apartment buildings (10 or more apartments) after 1981**	9,877,417	200	1,975,483,400
15.	**multi-apartment buildings (10 or more apartments) after 2001**	11,392,046	100	1,139,204,600
Total		**336 839 748**	**339**	**114,331,855,867**

Table 1. Building types with total floor area and energy consumption

(Source: Ministry of National Development, 2015)

In our model, we have assumed that mortgage-financed housing construction, new housing purchases and renovations are likely to improve (reduce) the environmental burden of energy use in the building stock through changes in the composition of the housing stock. It is important to emphasise here that we do not estimate the environmental effect of construction in our model, but only the impacts of compositional change due to the operation of the building, mainly related to energy use.

The "Bilan-Carbon" carbon footprint calculation method was used to calculate the initial environmental burden, which is compatible with existing standards (ISO 14064) and the GHG Protocol[4]. To this methodology, using the emission factors from the Clim'Foot database, so-called estimated average emission factors (tonne/kWh) were determined for different building types. To determine this, we estimated the average factors for each building type in terms of the proportion of energy used annually for lighting and heating/cooling (20–80 per cent). Based on the emission factors thus determined, an aggregate CO_2 emission

[4] The Bilan Carbone method was developed by the French ABC and ADEME, and it is based on the Base Carbone database, a publicly available emission factor database. The GHG Protocol and the ISO standard provide the framework for calculating the carbon footprint, while the specific emission factors are provided by databases compiled by research institutes.

was calculated for this baseline period of 2013.[5] In 2017, Hungarian emission factors were developed for the Bilan Carbone method under the LIFE Clim'Foot programme.

Aggregate CO_2 emissions were also calculated using another method. As a tool for this, the "emission factor" value of each building type – energy rating pair was taken from the European (including Hungarian) residential property emission database of the Partnership for Carbon Accounting Financials. The results were lower baseline CO_2 emissions in 2013, resulting in lower CO_2 emission savings associated with the assumed modernisation of the building stock. Considering that the most reliable information in the baseline database is the m2 data for the dwelling types, it is preferable to use emission factors (tonne/m^2) from this database to obtain results that best approximate reality. We could work with this methodology from February 2022, when the Partnership for Carbon Accounting Financials database became available.

In the next step, we used the model to try and reproduce how this initial state might have changed due to mortgage lending over eight years until the end of the period in 2021. For this purpose, we used the Hungarian Central Statistical Office's data table on mortgage lending for housing purposes[6], which distinguishes seven lending purposes: construction, new home purchase, modernisation/extension, purchase of a second-hand home, swing loan, loan conversion and other purposes.

In line with the modernisation of the housing stock, the stock of construction, new home purchase and modernisation/extension loans are fully considered in our model, as these are sure to finance more energy efficient and, therefore, "greener" properties due to increasingly stringent building regulations and energy requirements over the years.

In the case of loans for the purchase of a second-hand home, under the assumption that the buyer is likely to move into or rent out the property after some renovation, and thus energy efficiency improvements are also made, we also include some of these transactions (at rates of 5, 10, 15, 20 and 25 per cent) (see later). Swing loans, loan conversion and other loans were excluded.[7]

Based on the above, the number of loans available to make the composition of the building stock more favourable from energy-efficiency and, therefore, environmental point of view. In addition, to estimate the change in composition, we used the annual price per square metre statistics of new dwellings (HUF/m^2) published by the Hungarian Central Statistical Office for residential properties.

This was calculated annually and then summed over the period to determine how many square metres of the more modern property could be built or modernised with a given amount of mortgage loans. A very important feature and simplification of the model is that the total floor area of the building stock is kept unchanged. As the floor area of the more modern buildings was added, the floor area of all types was reduced proportionately, so the total square metres of the housing stock remained the same. Only the composition of the stock changed, becoming more modern. This gives us an essentially fictitious housing stock composition for the period under consideration, and we calculate an aggregate CO_2 emission for this condition.

As a last step, the difference between the CO_2 emissions in the current period (2021) and the baseline period (2013) is used to obtain the annual CO_2 emission reduction due to the modernisation of the housing stock thanks to mortgage lending.

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[5] Databases containing carbon footprint calculation emission factors: Base Carbone - https://bilans-ges.ademe.fr/en/accueil/contenu/index/page/bc_introduction/siGras/0, GHG Protocol - https://ghgprotocol.org/life-cycle-databases, EcoInvent Database - https://ecoinvent.org/the-ecoinvent-database/

[6] 18.1.1.16. Housing loans - https://www.ksh.hu/stadat_files/lak/hu/lak0016.html

[7] In the case of swing loans, no property modernisation can be expected, and the inclusion of loan conversions would result in duplication. Other loans (e.g. general purpose mortgage loans) are generally not for housing modernisation purposes, as the terms are less favourable than for housing loans.

A certain part of mortgage lending was financed by the MNB's Mortgage bond purchase programme, so in our model, based on a simple assumption, the MNB also contributes to the reduction of CO_2 emissions in the proportion of the amount of mortgage lending financed by its mortgage bond purchases and the amount of all mortgage loans in HUF.

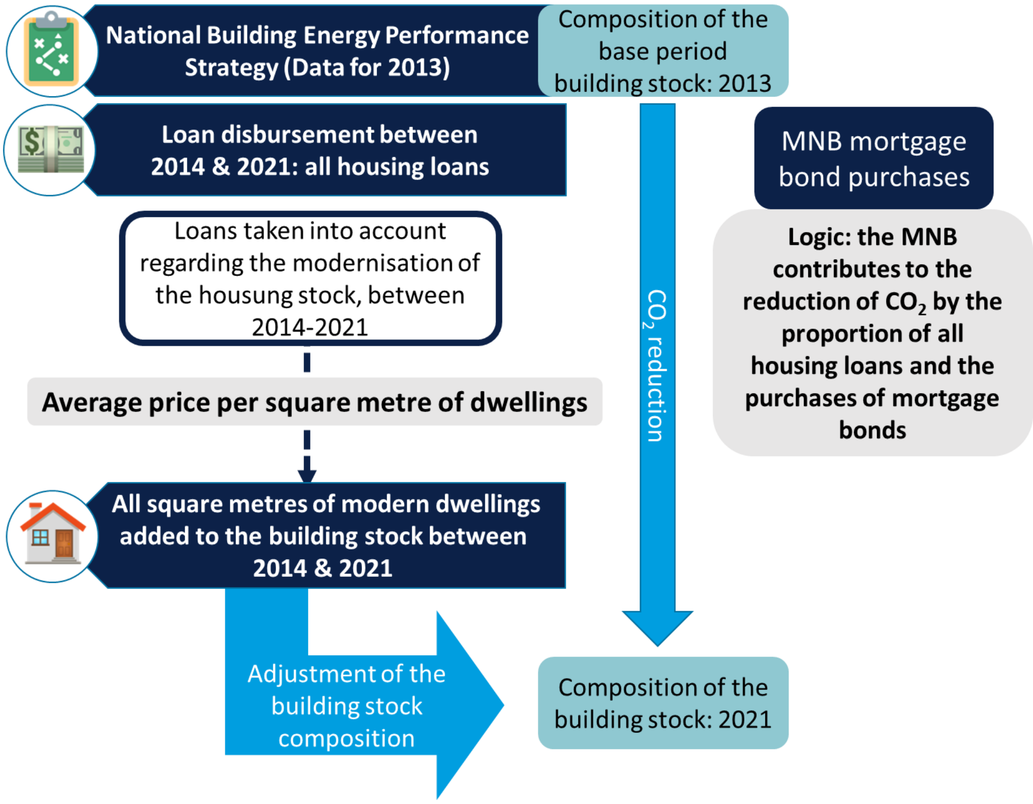

Figure 2. Presentation of the logic of the model

(Source: own edit)

5. Assumptions and estimation difficulties in the model

Regarding the methodology and the model, it is important to point out that several simplifying assumptions have been made. One of the key simplifications is that our calculations assume that the total area of the total housing stock does not change. This is a necessary simplification for the model, based on the assumption that the number of occupied properties where actual energy use takes place does not increase in the case of stagnating or decreasing population. In addition, the time elapsed between the disbursement of the loan and the construction of the property may also be a factor of uncertainty, but we do not believe this introduces a significant bias.

In addition, there are parameters to the assumption to which the model and its results are sensitive. As mentioned above, our calculations considered the number of mortgage loans used to purchase second-hand dwellings at a rate of between 5 per cent and 25 per cent for the improvement and modernisation of the composition of the housing stock. Another important factor is the energy efficiency of the "modern" square metres in the stock. We used values between 100 and 120 kWh/m^2/year in our calculations based on information from the Hungarian Central Statistical Office.

In addition, we explore several possibilities for the distortion caused by the collateral behind mortgage bonds. As described earlier, the underlying collateral for mortgage bonds must be ordinary assets (mortgage loans) of at least 80 per cent, but the proportion of ordinary assets is typically higher (varying by mortgage bond). The full possible range of 80 to 100 per cent was examined in this case. Furthermore, within ordinary assets, loans are secured by residential and commercial real estate. Nevertheless, the collateral for loans is typically residential property, in 98–99 per cent, so we do not include this in our analysis. Finally, it is very important to point out that the theoretical CO_2 emissions of the housing stock presented in the above model may differ significantly from the actual emissions because the building stock includes vacant properties and properties that are only used temporarily (holiday homes). In our model, therefore, we do not attempt to calculate accurate CO_2 emissions from actual energy consumption data based on the baseline (2013) or the current period (2021) composition of the building stock but to estimate the environmental burden reduction associated with the modernisation of the housing stock based on mortgage loan disbursement data for the period.

6. Presentation of the results

Based on our calculations, annual emission avoidance of between 13 and 41 thousand tonnes is estimated to result from the MNB's Mortgage bond purchase programme by modernising the housing stock. It can be seen that there is considerable uncertainty in the estimate, covering a relatively wide range, due to the assumptions and different scenarios tested.

By comparison, the actual CO_2 emissions from the cooling/heating of households in Hungary averaged around 15 million tonnes per year in the period under review. In comparison, the average annual CO_2 emissions from the operational activities of the Magyar Nemzeti Bank were around 6 thousand tonnes. Thus, according to the model, the MNB's Mortgage bond purchase programme can save Hungary approximately 2–7 times the MNB's annual carbon footprint on an annual basis due to the effect of the housing stock modernisation.

We want to organise and interpret the results. The best way to do this is to compare with impact reports. The impact reports show the environmental impact of the resources invested in green projects. The impacts are compared to an alternative scenario (in this aspect, they are similar to the model), which aims to show the positive environmental change that can be achieved by implementing the green project. In the case of mortgage bonds, this typically means the emissions saved through making the property more energy efficient.

Our results are compared with the impact reports of green mortgage bonds previously issued in Western Europe.[8] These are the basis for the comparison: each tonne of CO_2 emission avoided is calculated per year per million euros[9]. This is illustrated in the figure below, where light blue represents our estimated range of the MNB's contribution to emission avoidance:

[8] The green mortgage bonds of these financial institutions have similar characteristics to Hungarian mortgage bonds (except for their green character), which is why they were chosen as a basis for comparison and because impact reports are available for these few institutions.

[9] Using ECB exchange rate data: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/index.en.html

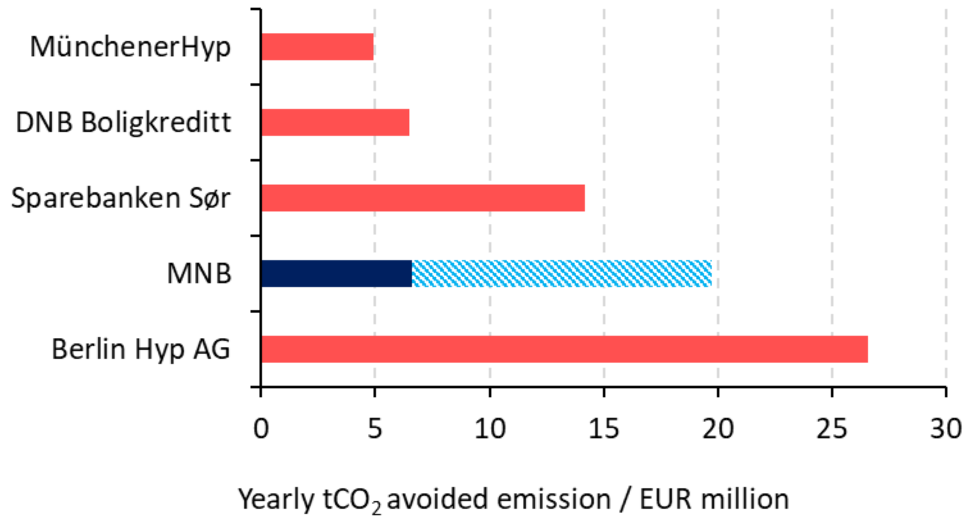

Figure 3: CO_2 emissions avoided per 1 million euro in tonnes per year for certain green bonds and the MNB's programme*

Source: MünchenerHyp[10], DNB[11], Sparebanken Sør[12], Berlin Hyp AG[13], MNB

*Note: The value reported regarding the MNB's programme is calculated using a different, specific estimation methodology and several uncertainty factors, so its comparison with the presented green mortgage bonds should be treated cautiously.

It can be seen that the MNB programme achieves a relatively high overall reduction in emissions per million euros. This may be partly because the Hungarian real estate stock is starting from a more outdated situation. Moreover, Hungarian real estate is relatively cheaper. Thus the amount of money invested may result in a larger reduction in emissions. It is also important to underline that different institutions may have different loan targets and property types behind their mortgage loans, with different criteria, which also affect the presented results. Finally, we would like to draw attention again to the model's uncertainties and assumptions. The comparison is an attempt to estimate the scale of the results of the MNB programme.

7. Summary

In our article, we attempted to estimate the environmental impact of the Magyar Nemzeti Bank's Mortgage bond purchase programme. After a brief introduction, we have attempted to review the relatively limited relevant literature available on the environmental impact of securities. We then presented the MNB Mortgage bond purchase programme, which was the subject of our analysis, and aimed to estimate its environmental impact. Our methodology was based on the changes in the composition of the Hungarian housing stock, and the main assumption was that, while maintaining the floor area of the housing stock unchanged, the financing of housing would have a modernisation effect due to the tightening building energy requirements and the renewal of the housing stock, which will lead to a reduction in emissions. In the methodological section, we presented our sources alongside the logic of our model. The assumptions and simplifications used in our calculations were then explained. These factors can significantly impact the results, so the estimations can only be evaluated under these assumptions and simplifications. Thanks to the MNB's Mortgage bond purchase programme, we estimate that the Hungarian building stock can reduce its CO_2 emissions by 13-41 thousand tonnes per year.

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[10] https://www.muenchenerhyp.de/sites/default/files/downloads/2021-05/mhyp_Impact_Reporting_2020_en_02.pdf
[11] https://www.ir.dnb.no/sites/default/files/3Q19%20Green%20Covered%20Bond%20Impact%20Report.pdf
[12] https://www.sor.no/globalassets/organisasjon/2020-green-impact-report.pdf
[13] https://www.berlinhyp.de/en/investors/green-bonds

References

Architecture2030. (n.d.). Why the build environment? URL: https://architecture2030.org/why-the-building-sector/ (Downloaded: 22 August 2022)

Becsi, A., Varga, M., Loga, M., & Kolozsi, P. P. (2022). First steps – the nascent green bond ecosystem in Hungary. *Cognitive Sustainability*, 1(1). DOI: https://doi.org/j362

European Commission. (2019). New guidelines on reporting climate-related information. URL: https://ec.europa.eu/info/sites/default/files/business_economy_euro/company_reporting_and_auditing/documents/190618-climate-related-information-reporting-guidelines-overview_en.pdf 10 August 2022.

Kolozsi, P. P., Ladányi, S. & Straubinger, A. (2022). Measuring the Climate Risk Exposure of Financial Assets – Methodological Challenges and Central Bank Practices. *Financial and Economic Review*, Vol. 21 Issue 1, March 2022, 113–140. DOI: https://doi.org/j363

Ministry of National Development. (2015). National Building Energy Performance Strategy. URL: https://ec.europa.eu/energy/sites/ener/files/documents/2014_article4_hungary_en%20translation.pdf

MNB. (2022a). The Magyar Nemzeti Bank's climate-related financial disclosure. URL: https://www.mnb.hu/letoltes/tcfd-jelente-s-2022-en.pdf (Downloaded: 12 June 2022)

MNB. (2022b). Green Finance Report. URL: https://www.mnb.hu/letoltes/20220718-green-finance-report-2022-3.pdf (Downloaded: 01 August 2022)

Nagy, T. & Winkler, S. (2021). Előremutató követelményekkel érhetünk csak el igazi eredményeket a zöldítés terén (Forward-looking requirements are the only way to achieve real results in greening). URL: https://www.mnb.hu/letoltes/nagy-tamas-winkler-sandor-zold-otthon-program-bb-kriterium.pdf (Downloaded: 22 August 2022)