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Carbon Intensity of Banks' Loan Portfolio – A Good Basis for Comparison in Case of Low-Income Countries?*

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In recent years, more and more credit institutions have been publishing the financed carbon footprint of their loan portfolio, enabling comparisons across institutions, for which investors and supervisors tend to use the carbon intensity of portfolios expressed as a proportion of the financed carbon footprint-to-total loan volumes. In this article, it is argued that such comparisons are unfair to low-income countries with low price levels, as they show the same activity as being more "carbon-intensive" in a low-income country than in a high-income country. The magnitude of such distortions can be significant, amounting to as much as 3 to 7-fold just within the European Union itself. As differences resulting from price levels do not actually represent differences in the carbon intensity of individual countries' real economy and are also not an "own choice" of these countries (but rather a consequence of the Balassa-Samuelson effect), it is argued that the comparison of carbon intensity of different banks' loan portfolios should be conducted using purchasing power parity adjustments – if not necessarily for investors, at least in the practice of financial supervisory authorities.

Journal of Economic Literature (JEL) codes: G21, M41, Q56, Q51, L52, F37, C81, C82

Keywords: carbon accounting, carbon footprint of banks, purchasing power parity

1. Introduction

In recent years, there has been more and more focus on the quantification of the financed carbon footprint of banks' loan portfolios in the financial sector. While there are no binding legal requirements for the quantification of banks' financed carbon footprint in force in the European Union or in any other developed economy, many credit institutions estimate and publish these figures on a voluntary basis as a sign of commitment to fighting climate change and/or under pressure from

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investors, supervisors or other stakeholders. Additionally, supervisory authorities have started to conduct comparisons of the carbon intensity of banks' loan portfolios, as the European Central Bank (ECB) did in its 2022 bottom-up climate change stress testing exercise (*ECB 2022a*).

The ability to compare the carbon intensity of individual banks' loan portfolios by putting them next to each other, however, does not necessarily mean that these comparisons provide meaningful information on which institutions are responsible for more pollution. One possible reason for this is that the underlying estimation methodologies are complex and heterogenous, i.e. there is inherent modelling risk stemming from the underlying quantification techniques.

Moreover, there may also be other systemic reasons that distort the comparison of the carbon intensity of loan portfolios across the financial systems of different countries, including factors such as the difference in nominal income and price levels of countries, structural differences in the depth of financial integration, etc. Such systemic distortions lie beyond the performance and choices of banks' managements, authorities and governments ("no fault of their own"), but may cause large differences in the carbon intensity of banks' loan portfolios. Such distortions are problematic, as they distort the "level playing field" across countries and institutions, while not reflecting any real differences in carbon emissions, and thus do not support the fight against climate change.

This article identifies such systemic distortions that are independent of actual pollution intensity and attempts to assess their impact.

The article is structured as follows: first, the context and basic methodology applied in the quantification of banks' financed carbon emissions are reviewed. Potential sources of systemic distortions that may impair comparability across institutions and financial systems are then discussed, and countries' different price levels are identified as the most important source of distortion. This impact is also illustrated using examples. Finally, the mechanism of the Penn effect and Balassa-Samuelson effect responsible for this distortion are briefly introduced and subsequently it is also demonstrated that the distortions stemming from the different price levels can be material, based on the example of EU countries. The article ends with a presentation of the conclusions.

2. Concept and role of banks' financed carbon footprint

2.1. Context and measurement of banks' carbon footprint

As the reduction of greenhouse gases (hereinafter: GHG) is a key front of the battle against climate change, one of the basic prerequisites for these efforts is the ability to measure GHG emissions. This is not only crucial for establishing and monitoring GHG reduction targets, but also for prudential reasons, as banks with more exposure to carbon-intensive borrowers also face higher transition risk.[1] The evaluation of loan portfolios based on their underlying carbon intensity is becoming an increasingly integral component of the risk assessment exercises conducted by central banks and financial supervisory authorities (for more on the domestic practice of the MNB, see *Bokor 2021; Kolozsi et al. 2022*; *Ritter 2022; or* from abroad, e.g. Banca d'Italia: *Faiella – Lavecchia 2022*).

In light of the foregoing, the GHG accounting methodology has undergone serious development in the last decade. According to the most widespread standard, the GHG Protocol (*World Resources Institute 2004*), all corporations (including banks) must distinguish the following levels of carbon emissions:

- *Scope 1 emissions*: direct GHG emissions of the corporation (e.g. from gas boilers, own vehicles, etc.);
- *Scope 2 emissions*: GHG emissions attributed to the energy (e.g. electricity, heat energy) utilised by the corporation; and
- *Scope 3 emissions*: all GHG emissions that arise in the value chain of the corporation.

The GHG emissions attributed to banks' loan portfolios are obviously part of banks' Scope 3 emissions. (However, it should be noted here that the GHG Protocol treats credit institutions in a somewhat exceptional manner, as it does not require the quantification of Scope 3 emissions for certain activities – such as the collection of deposits and financial transaction services – in banks' value chain). To quantify the Scope 3 emissions of banks' loan portfolios, a new global initiative was introduced in 2020: the PCAF (Partnership for Carbon Accounting Financials) methodology (*PCAF 2020*), which is presented briefly in the next section.

As of August 2022, no country in the world had a legally binding requirement for banks to calculate and publish the GHG emissions attributed to their loan portfolios. There are, however, "soft requirements"; for instance, in its Guide on climate-related and environmental risks, the ECB expressed its expectation that banks make their Scope 3 emissions publicly available (*ECB 2020a*). The MNB's so-called Green Recommendations also encourage domestic credit institutions to prepare estimations on their Scope 3 emissions in Point 40 (*MNB 2021a*) and maintained this during the 2022 update of the recommendation (point 51) (*MNB 2022*).

[1] A bank's transition risk is the risk of loan losses attributed to borrowers which will belong to the "losers" of the transition to a carbon-free economy, as their carbon-intensive business models can no longer be maintained.

Right now, only a fraction of banks publishes Scope 3 emissions of their loan portfolios: out of 112 credit institutions supervised directly by the ECB, only 15 per cent made such reports publicly available (*ECB 2022b*). However, in light of the existing supervisory pressure, it seems inevitable that more and more institutions will be publishing their Scope 3 emissions in the near future, paving the way for the more extensive use and comparability of such data.

2.2. Comparability of banks' carbon footprint based on carbon intensity in proportion to loan volume

Of course, the emissions of individual institutions expressed in terms of absolute volumes (in CO_2 equivalent) do not tell us much about how polluting an institution's business activity is, because it does not take into account the differences in the institutions' size. This limits the comparability of carbon footprints.

Therefore, in practice, the GHG emissions of institutions are often compared in proportion to some monetised or economic value, creating indicators for carbon intensity. Such indicators may be the carbon footprint related to invested amounts or carbon efficiency (emissions / revenues) and the weighted averages of thereof (weighted average carbon intensity, WACI).

In the case of credit institutions, the absolute carbon footprint of their loan portfolios is typically compared *to the financed loan volume* – in the rest of this analysis, this is referred to as the *carbon intensity of loan portfolios*.

3. Methodology to calculate banks' financed carbon emissions

To calculate the carbon intensity of banks' loan portfolios, it is necessary to estimate the borrowers' GHG emissions and then determine a mechanism to allocate "its share to the bank". The PCAF methodology determines the rules of this process, according to which the carbon footprint of the banks' loans is the borrower's total GHG emissions multiplied by the so-called attribution factor, which serves for the purposes of this allocation. However, the exact mechanism differs by loan product types.

3.1. Calculating the emissions of business loans

In case of the corporate loans, the basis is the total GHG emissions of the borrower:

$$\textit{Financed emissions of business loans} = \textit{Emissions of the borrower} * \textit{Attribution factor} \quad (1)$$

The attribution factor is calculated as the ratio of the loan volume provided to the borrower by the bank to the total assets of the borrower (or, in the case of publicly traded companies whose market capitalisation can be calculated, to the borrower's enterprise value, EV):

Attribution factor = Loans provided by bank / Borrower's total assets
or (2)
Loans provided by bank / (*Borrower's market cap* + *Borrower's liabilities – cash*)

In Equation (1), the total GHG emissions of the borrower can be determined based on several approaches: with the more sophisticated methodologies, the emissions are estimated from indicators of physical activities of the borrower (e.g. used energy in kWh, produced steel in tonnes, etc.), but this approach requires a great deal of data and measurements. Therefore, there are simpler approaches – especially for smaller, less sophisticated businesses – to estimate the borrower's emissions from its economic indicators by means of the environmentally extended input-output (EEIO) tables (for more details, see *Huppes et al. 2011*). (The practical application of the EEIO tables is presented in some articles such as *Teubler – Kühlert 2020*, as well as in the academic literature). This approach basically relies on industry averages as suggested by Equation (3). In 2022, the PCAF methodology requires the Scope 1 and 2 emissions of borrowers to be included in the estimation of banks' Scope 3 emissions for most corporations (with some exceptions), but borrowers' Scope 3 emissions will have to be gradually included into banks' carbon footprint by 2026 for all enterprises and industries.

Emissions of the borrower (*simple approach*) =
Borrower's revenue * (*Industry emissions / Industry output*) (3)

Replacing Equations (2) and (3) in Equation (1), it becomes obvious that the – recently most widespread, EEIO-based – simple approach estimates the emissions attributed to a loan basically as the product of the financing ratio of the company by the bank, the weight of the company within its (statistical) industry and the total GHG emissions of the given industry.

Financed emissions of business loans =
(*Loan provided by the bank / Borrower's total assets*) * *Industry emissions* * (4)
(*Borrower's revenue / Industry output* (*revenue*))

3.2. Calculating the emissions of mortgages

In the case of (residential) mortgage loans, the formula differs from that of business loans in such a way that the basis of calculation is the financed property's carbon footprint, not that of the borrower (see Equation (5)) and the attribution factor is the loan-to-value ratio of the transaction (see Equation (6)).

$$\textit{Financed emissions of mortgage loans} = \textit{Attribution factor} * \textit{Emissions of the property} \quad (5)$$

$$\textit{Attribution factor} = \textit{Loan provided by the bank} / \textit{Property's value at origination} = \textit{LTV} \quad (6)$$

$$\textit{Emissions of the property} = \textit{Energy consumption of the property} * \textit{Emissions factors} \quad (7)$$

Replacing Equations (6) and (7) in Equation (5) shows that the financed emissions of mortgage loans basically depend on the LTV, the energy consumption of the property and the emissions intensity of energy used by the household sector, i.e. from the composition and efficiency of the local energy mix.

$$\textit{Financed emissions of mortgage loans} = \textit{LTV} * \textit{Energy consumption of the property} * \textit{Emissions factors} \quad (8)$$

3.3. Other loans

PCAF defines approaches for another four asset classes, which are the following: listed equity and corporate bonds, project finance, commercial real estate finance and motor vehicle loans. These approaches are similar[2] to the two introduced above, at least at a level which is important for the subject of this paper. Consequently, they are not described in detail here.

4. Factors distorting comparability across countries

The previous section presented the calculation of borrowers' carbon emissions and the allocation of the proper share of such to the financing banks. The estimated GHG emissions attributed to banks' loan portfolios are often divided by the loan volume, in order to capture the carbon intensity per monetary unit. This section assesses systemic factors (which do not result from the banks' business strategy and cannot be changed or influenced by their management) that may distort the comparability of these carbon intensity measurements. As the carbon intensity is a ratio, the potential distorting factors can be related to the nominator or/and the denominator, and thus they result from:

- the estimated carbon emissions themselves, or/and
- the value of the total loan volume.

[2] For equities, bonds and project finance, the calculation method is similar to that of business loans, whereas the approach for commercial real estates and car financing is more like that of mortgage loans.

4.1. Factors distorting the comparability of carbon emissions in the case of corporate loans

Looking at corporate loans, the emissions attributed to different loan portfolios according to PCAF can differ from each other, basically for two possible reasons:

- *Corporate emissions*: estimated emissions will obviously be higher for more polluting companies. In this case, factors distorting comparability in a systemic manner may be connected to the different economic structures in different countries or their place in the international supply chains. Although the argument of "no fault of their own" could be considered here as well, showing more polluting regions or corporates as being indeed more polluting than others is appropriate, as their direct contribution to climate change is in fact larger and thus must be addressed.

- *General finance ratio* (*corporate leverage*): PCAF will show the carbon footprint of banks and financial systems which accept corporate borrowers with higher leverage as being larger than others. This would result in higher carbon footprints for banks in countries where corporate leverage is *ceteris paribus* higher than elsewhere. Although such differences might indeed reflect a higher share of responsibility of banks in carbon emissions, they could also be consequences of local characteristics such as the level of development of local financial markets, the capital accumulation ability of local corporates, etc. Indeed, there are some differences in average corporate leverage across EU countries, but these do not tend to be dramatic (see *Annex*).

An additional source of distortion could be the application of different estimation approaches across the banking industry. If corporate-level estimations are based on indicators of physical activity (according to the more sophisticated methods), rather than based on economic indicators (simpler methods), and these estimations differ from each other, that would not represent a source of distortion in itself, because the different results might only reflect the fact that the given company differs from its industry average. However, there is no evidence whether these approaches (the ones based on EEIO tables and the ones based on physical activity) would lead to the same results at the level of a whole industry; ultimately, this depends on how well the EEIO tables (which are also estimates) reflect reality. There is also no evidence on the consistency and reliability of corporates' own physical activity based GHG emissions, regardless of whether these are prepared or audited by independent third parties or not, but this goes beyond the scope of this paper. It must be noted, however, that some analyses (*Szigeti and Tóth 2016*) suggest that even estimations of GHG emissions based on similar approaches but performed by different actors for the same company may lead to inconsistent results.

Finally, another additional source of distortion could arise from the fact that PCAF allows the replacement of total assets by enterprise value in Equation (2), despite the fact that the latter is usually higher for companies with good future growth prospects. As a consequence, the carbon intensity of a loan provided to a non-listed company will be *ceteris paribus* higher than that of a listed company, giving an unfair advantage to fast-growing listed companies (as the carbon footprint allocated to the bank will be lower even if both companies conduct an equally polluting activity) and vice versa for slow-growing companies. However, it can be assumed that this distortion of comparability is not systemic across countries and financial systems.

4.2. Factors distorting the comparability of carbon emissions in the case of mortgage loans

Looking at mortgage loans, the emissions attributed to different loan portfolios according to PCAF can differ from each other, basically for two possible reasons:

- *Emissions of properties*: estimated emissions will be obviously higher for properties which consume more energy and/or from a more polluting energy mix. This can be attributed to the general conditions of buildings, to climate conditions or to physical/geographical limitations with regard to the local energy mix in different countries. Although all these reasons could be assessed as systemic and not alterable on the short run by economic actors, these differences reflect real differences in pollution and in the contribution of a given country to climate change. Therefore, such differences should remain reflected in the comparison of carbon intensity of banks' loan portfolios.

- *Typical LTV ratio*: this has a similar impact as the corporate leverage ratio above. In countries and financial systems where LTV ratios tend to be higher, the carbon footprint of mortgage portfolios will also be higher. Typical LTV ratios can differ significantly from country to country, which can be partially explained by regulatory factors (e.g. introduction or existence of LTV limits), but also by structural differences (such as borrowers' ability and/or willingness to accumulate savings). In fact, there are substantial differences between the average LTV ratios of mortgages across the member states of the euro area (LTV ranged between 53–87 per cent in 2016–2018) as published by the ECB (*ECB 2020b*). However, as in the case of the corporate leverage ratio, dividing the carbon footprint of mortgage loans by the loan volume, i.e. focusing on carbon intensity instead of the carbon footprint itself, eliminates the impact of this distorting factor.

Overall, the picture is very similar to that seen in the case of business loans: the differences in the carbon footprint of different banks' loan portfolios calculated according to PCAF mostly reflect real differences in the emissions of the underlying properties, and it is not possible to identify any factors that would clearly, materially and systematically distort the comparability of these measures across countries and financial systems.

4.3. Factors distorting the comparability of carbon intensity of portfolios: the effect of different price levels

As mentioned earlier, investors and supervisors do not compare the carbon footprints of different banks' loan portfolios directly to each other, but as a proportion to the total loan volume (expressed e.g. in emitted tonnes of CO_2 equivalent / euro), i.e. they compare carbon intensities rather than the carbon footprints themselves:

$$\textit{Carbon intensity of loan portfolio} = \textit{Financed emissions of loans / Total outstanding loan volume} \quad (9)$$

The above indicator will be distorted by the differences in general price and wage levels of different countries through the value of the total outstanding loan volume, completely independently of the real level of pollution of the underlying activities. The mechanisms through which this occurs are illustrated by two examples in the next section.

5. Impact of different price levels on carbon intensity

5.1. A business loan

Let us assume there are two entrepreneurs: $Entrepreneur_A$ operates in $Country_A$, while $Entrepreneur_B$ operates in $Country_B$. Each entrepreneur builds a house which is completely identical and constructed using the exact same technology from the exact same input materials. For the sake of simplicity, let us assume that all input materials are bought from abroad at the same price and quality (and obviously, the same carbon footprint) and all the energy needed for the construction (e.g. electricity, etc.) is produced from these input materials as well (i.e. the building process only has Scope 1 GHG emissions, while the Scope 2 emissions are zero). Finally, the entrepreneurs sell the finished houses to buyers.

Let us further assume that $Country_A$ is a high-income, high-price level country, while $Country_B$ is a low-income, low-price level country: price and wage levels in $Country_A$ are approximately twice as high as in $Country_B$. Therefore, both the price of the finished house and the wages of the construction workers will be more or less two times higher for $Entrepreneur_A$ than for $Entrepreneur_B$. Consequently, the rough financials of the two entrepreneurs will look as presented in *Table 1*.

Table 1
Financials of the two entrepreneurs and the carbon intensity of the loan provided by the financing banks

	Entrepreneur A	Entrepreneur B
Profit and loss		
Revenue (from selling the house)	100	55
Input materials	–10	–10
Labour costs	–60	–30
Profits of the entrepreneurs	30	15
Funding		
Loan borrowed from banks (financing ratio = 100%)	70	40
Carbon emissions of the project		
Total GHG emissions (in CO_2-equivalents)	x	x
Carbon intensity of the loan provided by the financing bank		
Scope 3 emissions of the loan	x/70	x/40

It is assumed that both entrepreneurs funded 100 per cent of the project from a loan borrowed from a bank (their equity was zero), i.e. Entrepreneur_A borrowed 70 units, whereas Entrepreneur_B borrowed only 40 units. As the construction activity of the entrepreneurs produced the exact same amount of GHG emissions (this is denoted by x), the carbon intensity of the loans (Scope 3 emissions / total loan volume) in case of Entrepreneur_A will amount to x/70, whereas it will be x/40 in case of Entrepreneur_B. Thus, the carbon intensity of these two different loan portfolios will differ by a factor of almost two, despite the fact that the underlying financed activity was equally polluting.

5.2. A mortgage loan

Now, let us assume that the two houses above are bought by two different private persons in Country_A and in Country_B. They both take out a mortgage loan with an LTV of 60 per cent from their banks, i.e. the buyer in Country_A borrows 60 units, whereas buyer in Country_B borrows 33 units. Let us also assume that the energy consumption of the two buildings is identical, meaning that the underlying energy mix of the two countries is also identical (expressed, for example, in terms of CO_2-equivalents / kWh). Let y denote the annual GHG emissions of the two buildings.

In this case, the GHG emissions of these mortgage loans allocated to the financing banks according PCAF will be y/60 and y/33 in Country_A and in Country_B, respectively. In this case again, the carbon intensity of the different mortgage loans in Country_A and in Country_B will be different by a factor of two, despite the underlying activity (asset) being equally polluting here as well.

The above examples illustrate how different price and wage levels in different countries necessarily cause a distortion in the comparison of carbon intensities of loan portfolios.

6. Reasons for different price levels across countries and their magnitude in the EU

The above distortions have a significant negative impact on the comparability of carbon intensities if there is indeed a major difference between countries' price levels that is non-random and independent of the real level of pollution. This section demonstrates that these differences do indeed exist and that they are systemic in nature as they can be explained by development levels. Therefore, they cannot be influenced by the decisions of banks in the short run and probably not even in the longer run either.

Although the purchasing power parity (PPP) theory of classical economics assumed an eventual convergence in the prices of different countries, in reality this has never occurred since the early 1950s, as documented by the so-called "Penn studies" (e.g. *Kravis et al. 1978*), which also established the practical fundamentals of the PPP-correction for international income data. A phenomenon – called the "Penn effect" based on these papers – was observed, according to which high-income countries also tend to have higher price and wage levels.

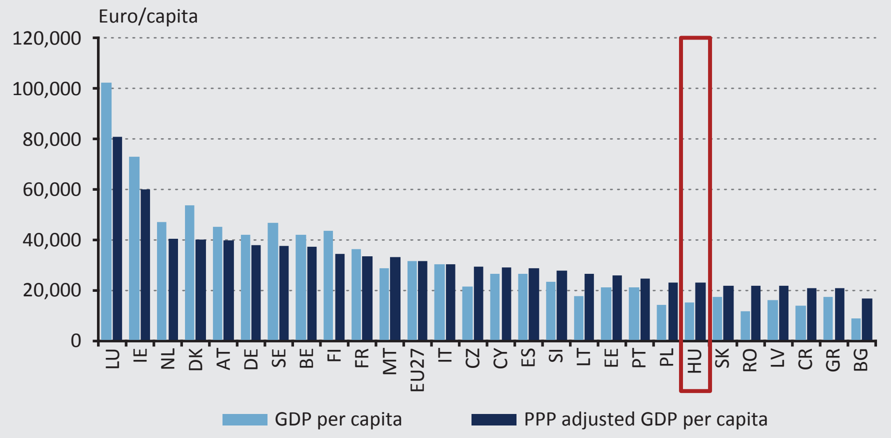
The reason for this phenomenon is explained mostly by the "Balassa-Samuelson effect" which can be briefly summarised as follows: all countries produce tradeable goods, which can be sold anywhere in the world economy, and non-tradeable goods, which can be sold only locally. The tradeable goods (e.g. a mobile phone) tend to have a single price which is more or less the same everywhere around the world (otherwise arbitrage would be possible by buying them where they are cheap and selling them where they are expensive), whereas the non-tradeable goods (e.g. a haircut) have prices which can differ across countries. In more developed countries, the productivity of labour is higher for tradeable goods, and therefore the wages of workers employed in the tradeable sectors will also tend to be higher. This, however, would not be sufficient to explain the differences in price level across countries. It is also necessary that wages in the non-tradeable sector also be higher in more developed countries, even though the labour productivity of non-tradeable workers might be the same everywhere (hairdressers are more or less equally productive in developed and developing countries). This can have many reasons: for example, the higher demand (purchasing power) from workers employed in the tradeable sector, the potential substitution of labour between the tradeable and the non-tradeable sector, etc.

Analysing the impact channels of the Balassa-Samuelson effect is beyond the scope of this paper, but a good summary can be found in the introductory chapter of

Pancaro's paper (*Pancaro 2011*) for example. Actually, for the purposes of this study, it is irrelevant what exactly explains the Penn effect. What is important is that it exists and it is material, as is demonstrated for the countries of the European Union below.

To filter out the distortions caused by Penn effect in income data such as GDP, a purchasing power parity (PPP) adjustment is applied in order to remove the impact of different price levels from the economic performance of different countries and enhance their comparability. As price levels correlate with the level of development, PPP-adjusted GDP data show a smaller difference in the real economic performance of countries: for instance, in the EU, differences between Member States based on *nominal* GDP per capita are in a range of up to 12 times between the poorest and the richest, but after PPP adjustment the differences diminish to a magnitude of "only" five times (*Figure 1*).

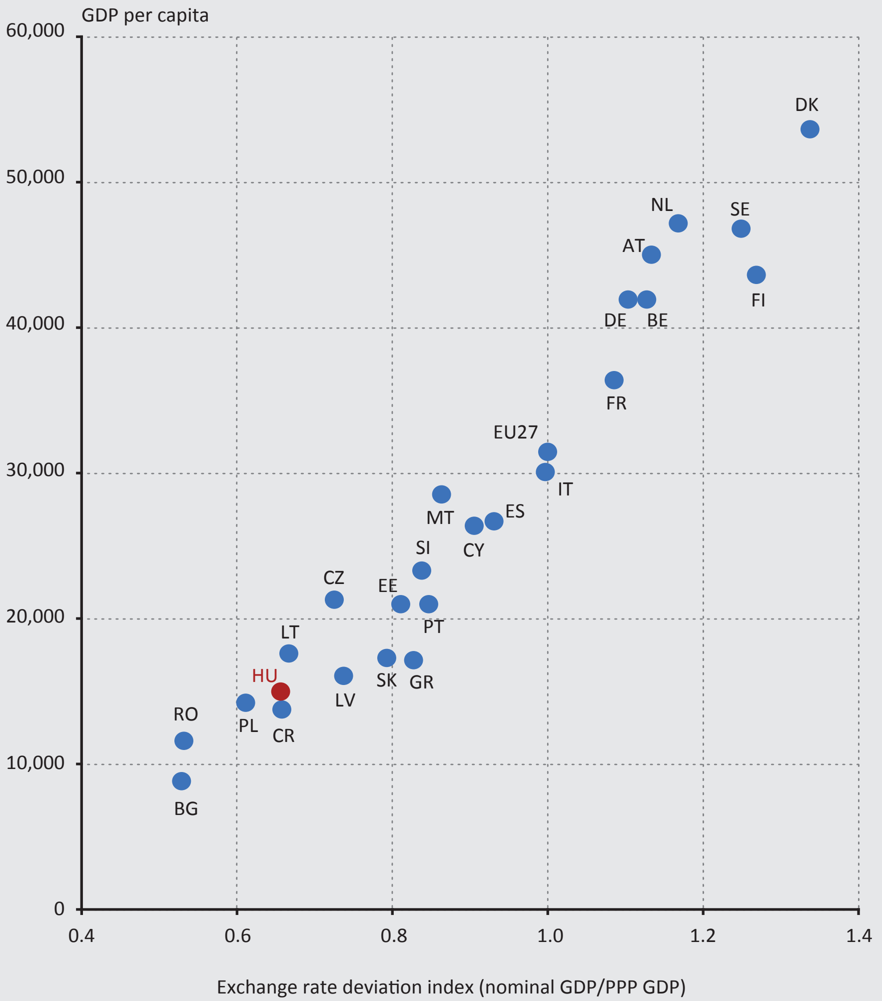
Figure 1
Per capita GDP based on nominal GDP and PPP-adjusted GDP data in EU countries, 2019



Source: Eurostat

Figure 2 also illustrates that differences in price levels across countries are non-random: correlation between the level of development and the necessary PPP-adjustment factors is strong for EU countries, as the correlation coefficient between these two is 0.84. PPP-adjustment factors in this chart reflect the relative price levels showing a significant difference between countries: for example, the differences between Bulgaria and Denmark have a magnitude of 2.5 times, meaning that on average the same good costs 2.5 times more in Denmark than in Bulgaria.

Figure 2
PPP-adjustment factor (exchange rate deviation index) and nominal GDP per capita in EU countries

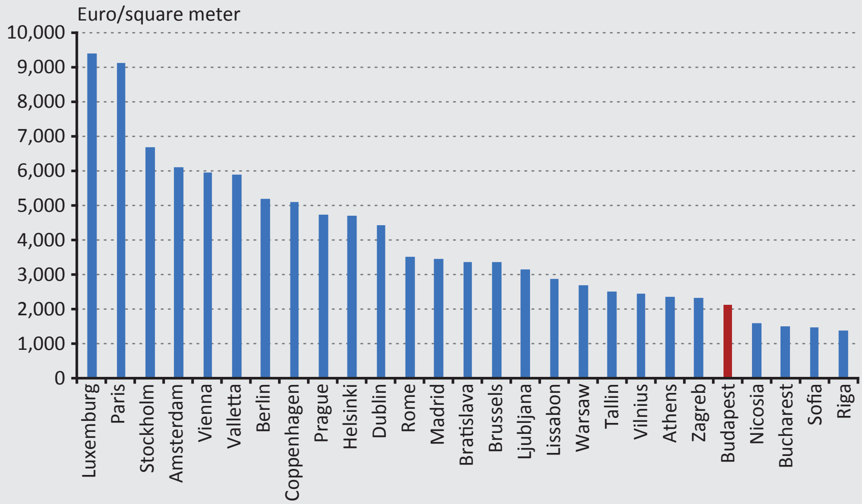


Notes: All data for 2019; data for Ireland and Luxembourg were omitted as these countries have extreme values in terms of nominal GDP for several reasons. However, the omission of these two countries does not change the correlation between the PPP-adjustment factor and the level of development of the EU countries.

Source: Calculations based on Eurostat data

Furthermore, differences in price levels may be even bigger than above in certain subsegments of the economy: e.g. real prices across countries of the EU can differ even by 6–7 times between certain regions of the EU (*Figure 3*), although these differences may also be due to non-systemic, unalterable factors, other than differences in economic development (e.g. local regulations, interest rate environment, etc.).

Figure 3
Real estate prices in selected European cities



Note: The indicated property prices are "Price per Square Meter to Buy Apartment Outside of Centre" as defined by numbeo.com. As the data at numbeo.com are not compiled based on a representative sample, they should be treated with utmost caution.

Source: numbeo.com, prices downloaded in June 2022

Adjustment with PPP is also not completely unknown in the case of environmental sustainability statistics: the World Bank, for example, publishes country-level GHG emissions as a proportion to PPP-adjusted GDP data among its World Development Indicators (*World Bank 2022*). The MNB also published a regional comparison of CO_2 emissions of Hungary based on PPP-adjusted data in its Sustainability Report (*MNB 2021b: p. 23*). However, this approach is not yet widespread, as already noted with regard to the 2022 bottom-up stress test of the ECB.

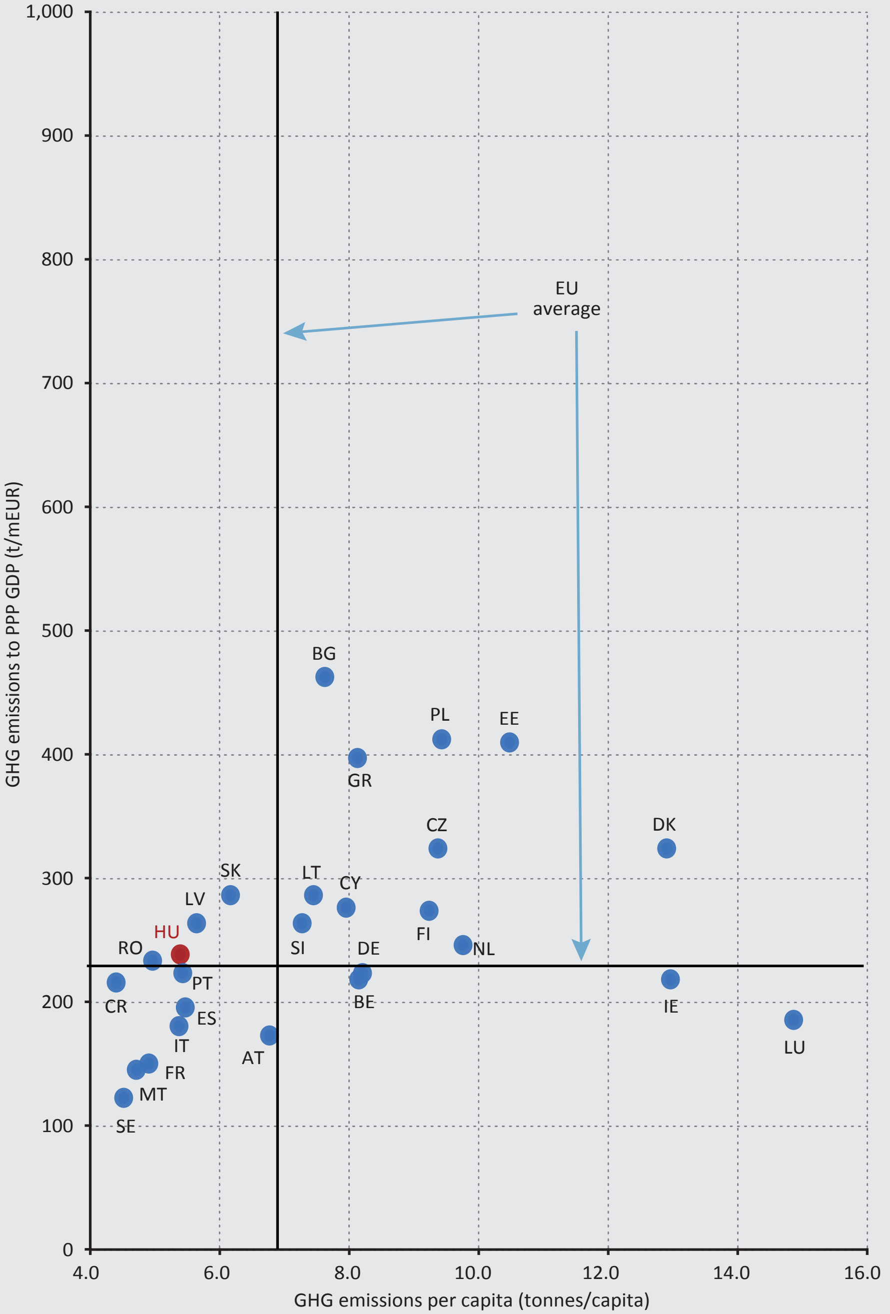
7. Magnitude of the distorting effect of different price levels in comparisons of carbon intensity within the EU

How different price levels – if not adjusted – could impact the comparison of the carbon intensity of banks' loan portfolios in different countries can be estimated by comparing GHG emissions data of different countries in proportion to their nominal and PPP-adjusted GDP. *Figure 4* shows EU countries' GHG emissions related to their nominal, non-PPP-adjusted GDP. *Figure 5* shows the same, but with PPP-adjusted GDP. The per capita GHG emissions of the countries are added to both charts for the sake of comparison.

Figure 4
GHG emissions of EU countries in proportion to their population and nominal GDP (in tonnes of CO_2-equivalent), 2019

Source: Eurostat

Figure 5
GHG emissions of EU countries in proportion to their population and PPP-adjusted GDP (in tonnes of CO_2-equivalent), 2019



Note: GHG emissions in CO_2-equivalent
Source: Eurostat

Figures 4 and *5* show that differences in GHG intensity of the economies of EU Member States – if not corrected for different price level – can be even in the magnitude of 9 times (between Bulgaria and Sweden). Once the data are adjusted for price level differences, the difference between the most-polluting and least-polluting economies diminishes to a magnitude of "only" 4 times. The two charts also show that the PPP-adjusted carbon emissions intensities are more in line with the per capita-based GHG emissions values (although the two differing from each other does not reflect distortion in itself, as it only shows that there are differences in the level of real economic activity across countries as well).

8. Conclusions

The analysis shows that the carbon intensities of banks' loan portfolios as expressed in proportion to total outstanding loan volume can be very different from each other merely because of the different price and wage levels of countries. Such differences do not reflect any real difference in the pollution level of economic activities, and therefore they can be interpreted as a factor distorting the comparability of loan portfolios' carbon intensities across countries. As differences in price and wage levels vary non-randomly across countries and are rather the inevitable consequences of the different income and productivity levels of countries (due to the Penn or Balassa-Samuelson effect), this distortion will make equally-polluting real economic activities in low-income countries look *ceteris paribus* systematically more polluting.

How to treat the consequences of this distortion depends also on the point of view of economic actors and the purposes of their decisions.

From investors' point of view, taking into account this distorting impact might not be necessary. If investors seek to minimalise or at least limit the carbon footprint related to their investments, then adjusting their portfolio's carbon intensity for the different price levels would be unjustified. After all, the investment of 1 million euro will "buy more pollution" in a low-income country, than in a high-income country, because it can fund more real economic activity.

However, from the point of view of economic policy or banking supervision – especially in the EU's single market – not considering this distortion effect violates the principle of a "level playing field". If bank supervisors penalise credit institutions, loan portfolios and economic activities based on the *absolute* value of carbon intensity without adjusting it for different price levels, it causes a competitive disadvantage for low-income countries and their financial systems. Such an approach would raise questions with regard to fairness and social justice, as it would penalise polluting activities in high-income countries less, just because they are high-income countries. Therefore, for the purposes of economic policy and banking supervision, this paper finds that the carbon intensity of loan portfolios should be adjusted by purchasing power parity.

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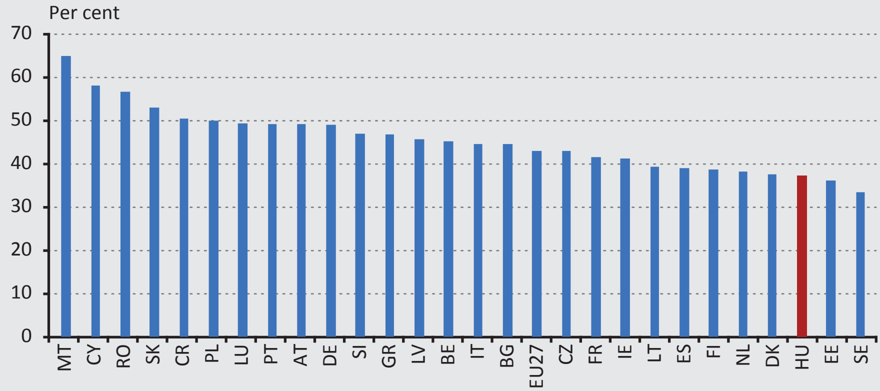
Annex: Dependence on external financing of non-financial corporates in EU countries

Figure 6
External liabilities / (all liabilities + equity) of non-financial companies in EU countries, 2019



Note: Consolidated data

Source: Eurostat, financial accounts