Occasional Studies
Volume 19 - 1

Misleading Footprints

Inflation and exchange rate effects in relative carbon disclosure metrics

DeNederlandscheBank

EUROSYSTEEM

Misleading Footprints.
Inflation and exchange rate effects in relative carbon disclosure metrics

Authors
Artjom Janssen, Justin Dijk and Patty Duijm

The authors thank, without implicating them, Emily Bell, Wouter Botzen, Maurice Bun, Jan Willem van den End, Joelle Jürgensen, Iman van Lelyveld, Pieter Moore, Danijela Piljic, Nikki Rupert, Guido Schotten, Joris van Toor, and attendants at internal seminars and presentations for their valuable comments. Any remaining errors are ours.

De Nederlandsche Bank N.V.
P.O. Box 98
1000 AB Amsterdam
www.dnb.nl
Email: info@dnb.nl

Misleading Footprints

Artjom Janssen
Justin Dijk
Patty Duijm

Table of contents

Summary

Financial institutions need robust statistics to measure and manage climate-related risks and determine their sustainability improvements over time. The physical effects of climate change, such as more frequent and severe floods and extreme weather, can have a major impact on the financial risks facing the financial sector. The transition to a more sustainable economy can also lead to so-called transition risks. Due to climate policy, technological developments and changing consumer preferences, current investments in companies with relatively large greenhouse gas emissions can decrease in value faster than expected. At the same time, the investment choices made by the financial sector can ensure that sufficient capital is made available for the investments needed to achieve the goals of the Paris Agreement. The development of robust climate change statistics to measure both risk and impact is a key priority at DNB. Improving our confidence in backward-looking metrics such as carbon disclosure metrics, enables central banks and supervisors to determine the transition risks facing the financial sector, whether the financial sector is on the right track toward reaching its sustainability goals, and ensures that forward-looking tools such as scenario analysis and stress tests use better historical information to estimate financial risks.

The aim of this report is to share a specific recommendation for the further development of a global harmonized reporting standard. We introduce a method to adjust relative carbon disclosure metrics for inflation and exchange rate effects. The results of this report show that relative carbon disclosure metrics are particularly vulnerable to changes in monetary values over space and time.

Relative carbon disclosure metrics such as the Weighted Average Carbon Intensity (WACI) are currently recommended in international reporting standards. Carbon disclosure metrics can be classified in two general sets – absolute and relative metrics. Absolute metrics typically measure total emissions of a portfolio in tonnes of CO_2 equivalent[1] emissions. Relative carbon disclosure metrics normalize emissions for instance by company revenue – e.g. 'tonnes of CO_2 equivalent emissions / EUR million revenue'. Relative metrics thus account for the fact that larger companies tend to emit more as they produce more, or that larger asset portfolios are typically responsible for higher absolute emissions. Hence, relative metrics allow for the (international) comparison of portfolios of specific financial institutions or sectors, such as banks, pension funds or insurers. Absolute footprints are more difficult to compare across portfolios, but are deemed as important as relative metrics to determine climate-related risks and portfolio alignment with the Paris Agreement.

[1] Greenhouse gases like CO_2, CH_4 and N_2O are typically converted to CO_2-equivalents using weights to reflect the contribution of a tonnes of emissions of a specific greenhouse gas to global warming relative to a tonnes of CO_2 emissions.

Actual sustainability improvements in the Dutch pension and insurance sector are notably smaller when inflation and exchange rates effects are adjusted for. The results show that the unadjusted relative carbon disclosure metrics for Dutch pension funds and insurers are significantly different from their adjusted counterparts. From 2012 to 2019, the unadjusted Weighted Average Carbon Intensity (WACI) of Dutch pension funds and insurers decreased on average by 34.5% and 31.0%, respectively. The adjusted WACI shows notably smaller improvements of 24.1% and 23.7%, respectively. The reduction in sustainability improvements in this particular application are mainly driven by the adjustments for inflation, and to a lesser extent by exchange rate effects.[2] Other commonly used and recommended relative carbon disclosure metrics such as the relative Carbon Footprint (CFP) and the Carbon Intensity (CI) show similar differences. DNB therefore recommends using adjusted relative carbon disclosure metrics instead of unadjusted metrics.

These findings are significant for the creation of a harmonized global environmental disclosure framework. The need to adjust relative metrics for inflation and exchange rate effects should be added to the list of issues that makes establishing a harmonized global framework challenging. Among others, the Task Force on Climate-related Disclosure (TCFD) does not yet acknowledge the difficulties associated with comparing monetary values across space and time.

Corporate and financial sector disclosures on climate-related information should improve in quantity, quality and consistency. Other important unresolved issues include (carbon) emission data coverage, the lack of (consistency in) corporate disclosures of Scope 3 emissions, and the fragmented landscape of voluntary standard setting organizations, third-party (commercial) data providers, and the differences in their methods and applications to provide (actual or modeled) carbon disclosure metrics and the emissions data these are based upon. Credible and comparable sustainability information, complementing the financial information already available, should be readily available for all market participants, shareholders and other stakeholders to offer meaningful insights in the role the financial sector plays in reaching net-zero emissions by 2050. The metrics that the financial sector is able to report are only as reliable as the corporate disclosures they are built upon.

In cooperation with international organizations, DNB will continue its research to contribute towards the creation of a harmonized global framework for climate-related financial disclosures. Current efforts by the IFRS foundation, a key global standard setting body for corporate reporting, trigger expectations that a global sustainability standard might

[2] Note that when exchange rate effects have the upper hand and/or deflation occurs in a particular dataset, adjusted metrics can in fact show larger sustainability improvements compared to their unadjusted counterparts. The direction of the results is thus very much dependent on the geographical composition of the portfolio and the time period that is studied.

soon be developed and take effect at some time in the future. Other important efforts that push forward the goal of reaching a harmonized global standard are for instance the EU's Non-Financial Reporting Directive (NFRD), the EU's Regulation on the sustainability-related disclosures in the financial services sector (Regulation 2019/2088), and global organizations such as the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), and the Sustainability Accounting Standards Board (SASB). Until a harmonized global reporting standard is in place however, the Network for Greening the Financial System (NGFS), and its ever-expanding group of central banks and supervisors, can for instance assist in ensuring that best practices are shared and applied consistently among its global membership. The findings of this report have been shared with the TCFD, the NGFS and other relevant channels.

1. Introduction

The international and political debate on climate change intensified over the last years. The existence of anthropogenic climate change has been thoroughly studied since the 1950s. In these early years, linkages were already made between carbon dioxide (CO_2) concentrations and global warming (Le Treut et al., 2007). To this day, there is scientific consensus that global emissions must drop by 50% over the next decade in order to have a chance of staying at 1.5 degrees of global warming and thus avoid the most catastrophic consequences of climate change (IPCC, 2018). Despite calls for action over the following decades to curb emissions, society at large has failed to sufficiently act upon them.

The role of the financial sector in climate change has gained attention more recently. Ratified in 2016, the Paris Agreement is considered to be a milestone in global climate change governance, and the financial sector in particular is considered to fulfil an important role in decarbonising the economy (Lagarde, 2020). At the end of 2020, the EU leaders agreed to increase the EU's emission reduction target to 55 percent by 2030. Financial institutions, such as pension funds and insurance companies, have a large amount of assets under management. Their investment choices thus have a significant impact in steering the provision of credit away from carbon intensive industries and on a pathway towards lower absolute emissions. This key role that the financial sector plays can be monitored through the reporting of metrics that take into account the sustainability of their investment portfolios.

Various international organizations are working together to create harmonized climate-related disclosure frameworks for the financial sector. Despite the efforts by these organizations, such as the Task Force for Climate-related Financial Disclosures (TCFD), the Network for Greening the Financial System (NGFS) and the Partnership Carbon Accounting Financials (PCAF), to this day there is no commonly agreed set of metrics and/or mandatory requirement in place to report and disclose corporate and financial carbon footprints (Buchner et al., 2019). There are multiple reasons why this has not occurred yet. For instance, there are unresolved methodological, accounting and data-dependent issues which make creating one common framework challenging (NGFS, 2019a). Furthermore, there is a clear dependency as the metrics that the financial sector can disclose are only as reliable as the corporate disclosures they are built upon.

The aim of this report is to contribute to the ongoing work on carbon disclosures by flagging and solving two methodological issues that are currently hampering the potential of *relative*[3] carbon disclosure metrics. In this study we show that inflation and exchange rate effects can have a substantial impact on relative carbon disclosure metrics used in global financial disclosures (TCFD 2017). Both of these macroeconomic effects pose challenges when observing time series of carbon disclosure metrics that partially depend on monetary variables, especially when various national price levels and currencies are involved (Eurostat, 2013). We propose solutions to correct for the distortionary effects that inflation and exchange rate fluctuations have on the outcomes of these metrics. Improving our confidence in backward-looking metrics such as absolute and relative carbon footprints, enables central banks and supervisors to determine whether the financial sector is on the right track toward reaching the targets of the Paris Agreement. Furthermore, it ensures that forward-looking tools such as scenario analysis and stress tests use better historical information to determine the risks facing the financial sector.

To show the impact that inflation and exchange rate fluctuations have, this report uses data on the financial portfolios of equities and corporate bonds of Dutch insurance companies and pension funds. The data used to estimate the carbon footprint metrics covers 40.2% and 29.8% of the equity and corporate bond asset classes of the pension fund's and insurer's portfolios in 2019Q4 respectively.

The focus of this report is on the Weighted Average Carbon Intensity (WACI) measure, since this is the measure that is most commonly used. For example, the TCFD recommends its members and clients to use the WACI metric as the optimal method to disclose their financial carbon intensity and as a consequence, various large financial institutions have adopted the TCFD methodology. We do however test for the robustness of our conclusions by also presenting the impact of adjusting for inflation and exchange fluctuations in other commonly used relative metrics, such as the Carbon Footprint (CFP) and the Carbon Intensity (CI).

This report shows that adjusting relative carbon disclosure metrics for inflation and exchange rate fluctuations makes a significant difference to the level and dynamics of these metrics over time. From 2012 to 2019, the standard – i.e. unadjusted – WACI for the Dutch pension fund and insurance sector decreased on average by 34.5% and 31.0% respectively. The adjusted WACI – i.e. the WACI adjusted for inflation and exchange fluctuations

[3] Carbon disclosure metrics can be classified in two general sets – *absolute* and *relative* metrics. While the former class looks at aggregate emissions, the latter normalises emissions to a performance indicator. A relative carbon metric accounts for the fact that larger companies tend to emit more as they produce more, or that larger asset portfolios are typically responsible for higher absolute emissions. Therefore, relative carbon footprints have an advantage as they allow for companies' and financial portfolios' exposure to carbon-intensive practices and sectors to be easily compared (TCFD, 2017). The scope of this study is confined to the relative carbon disclosure metrics, and the primary focus is the Weighted Average Carbon Intensity (WACI) as defined by the TCFD, and readily adopted by many organisations (J.P. Morgan, 2020; MSCI, 2020; Robeco, 2020; Aviva, 2019).

– however shows an improvement of only 24.1% and 23.7% respectively over the same period. While the standard WACI is valid to observe and compare portfolios at a certain point in time, this report shows that in order to meaningfully interpret and compare the WACI over a particular time horizon, it is necessary to correct for inflation and exchange rate fluctuations. These fluctuations stem from the particular characteristics of the portfolio (i.e. currency basket and geographical composition of investments). This report also shows that these findings carry over to other relative carbon disclosure metrics. When a large share of the investments in a portfolio are denoted in a currency (the "dominating currency") that differs from the currency used in the unit, and/or there are large fluctuations in these currencies, the exchange rate effect becomes larger. Similarly, when inflation (or deflation) occurred in the currencies that are part of the sample during the period of observation, adjusting for this effect will impact the WACI and other relative disclosure metrics.

The findings in this report contribute towards the creation of a harmonized framework for climate-related financial reporting. More specifically, the results directly contribute towards the recommendation made by the NGFS to achieve a "robust and internationally consistent disclosure framework" (NGFS, 2019a). Current efforts by the IFRS foundation[4], a key global standard setting body for corporate reporting, trigger expectations that a global sustainability standard might soon be developed and take effect at some time in the future. Other important efforts that push forward the goal of reaching a harmonized global standard are for instance the EU's Non-Financial Reporting Directive (NFRD), the EU's Regulation on the sustainability-related disclosures in the financial services sector (2019/2088), and the work of global organizations such as the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), and the Sustainability Accounting Standards Board (SASB).[5] Until a harmonized global standard is in place however, the Network for Greening the Financial System (NGFS), and its ever-expanding group of central banks and supervisors, can for instance assist in ensuring that best practices are shared and applied consistently among its global membership. The findings of this report have been shared with the TCFD, the NGFS and other relevant channels.

The remainder of this study is structured as follows. Chapter 2 discusses the relevance of carbon disclosure metrics, and deals with the definitions of metrics that are currently used by, and recommended to, the financial sector. Chapter 3 introduces the proposed methodological solutions to deal with inflation and exchange rate fluctuations in the calculation of carbon disclosure metrics, and discusses the data used in this study. Chapter 4 considers the impact of

[4] See for instance the IFRS consultation paper on Sustainability Reporting: https://www.ifrs.org/projects/work-plan/sustainability-reporting/comment-letters-projects/consultation-paper-and-comment-letters/
[5] See for instance the CDP, CDSB, GRI, IIRC and SASB's shared vision for a comprehensive corporate reporting system: https://www.sasb.org/blog/progress-towards-a-comprehensive-corporate-reporting-system/

correcting for inflation and exchange rate fluctuations in the calculation of multiple relative carbon disclosure metrics for investment portfolios of Dutch insurance companies and pension funds, and discusses differences in the impact of these corrections between portfolios. Chapter 5 concludes, reflects on the path toward a harmonized global framework for climate-related financial disclosures and discusses areas for further research.

2. Relative carbon disclosure metrics

2.1 Objective

There are various initiatives working on creating a coherent carbon accounting, reporting and disclosure framework. In the financial sector, organisations such as the Task Force for Climate-related Financial Disclosures (TCFD), and the Partnership Carbon Accounting Financials (PCAF) are working to create a harmonized greenhouse gas (GHG) disclosure framework that can be used by financial and non-financial corporations worldwide (TCFD, 2019; NGFS, 2019a; PCAF, 2019). Other important global organizations that push forward the goal of reaching a harmonized global standard are the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), and the Sustainability Accounting Standards Board (SASB). A harmonized global framework will greatly benefit all stakeholders involved – disclosing companies, (potential) investors, governments, supranational organisations and society at large, since such a system will help map out the current landscape, offer a level playing field, and incentivise stakeholders to contribute to decarbonising the global economy.

Although diverse carbon disclosure initiatives have arisen in the past years, to this day there is no common metric to report and disclose corporate and financial carbon footprints (Buchner et al., 2019). There are multiple reasons why this has not occurred yet. For instance, there are unresolved methodological, accounting and data-dependent issues which make creating one common framework challenging (NGFS, 2019a). Examples include the data coverage of unlisted assets, the lack of (consistency in) corporate disclosures of Scope 3 emissions, and the fragmented landscape of voluntary standard setting organizations, third-party data providers, and the differences in their methods and applications to provide (actual or modeled) carbon disclosure metrics and the emissions data these are based upon. In addition, most companies are not yet obliged to disclose their emissions, while those that are obliged, fail to do so because there is no framework for accountability (Harvey, 2019). Furthermore, emission data are usually reported on an annual basis, such that there is always a lag between the disclosures and the present situation. The EU Technical Expert Group (EU TEG) on sustainable finance is currently in the process of finalizing the taxonomy by which it will be easier to classify and distinguish green, sustainable assets from brown assets (EU TEG, 2020). Alongside the EU's Non-Financial Reporting Directive (NFRD) and the EU's Regulation on the sustainability-related disclosures in the financial services sector (2019/2088), the taxonomy contributes to the creation of a harmonized framework for climate-related disclosures within the EU.

At the same time, some consequential methodological limitations have not been addressed yet. For instance, the TCFD – a global leader in carbon-related financial disclosures

– does not yet acknowledge the difficulties associated with comparing monetary values across space (different currencies) and time (inflation) in their proposed carbon footprint metrics. However, countries having different price levels and currencies poses a challenge to the interspatial comparison of prices and volumes (cf. Eurostat, 2013. p.303). The next section presents some carbon metrics that are currently used.

2.2 Existing metrics

At the moment, there are various metrics being used that aim to measure the carbon intensity of a portfolio; in this study we make use of three existing metrics. The TCFD (2017) presents and describes five main metrics in their 2017 report; i) Weighted Average Carbon Intensity (WACI); ii) Carbon Intensity (CI) ; iii) Carbon Footprint (CFP); iv) Total Carbon Emissions (TCE); and v) the exposure to carbon-related assets. The TCE and the exposure to carbon-related assets are not taken into account in this study, since these metrics belong to the so-called absolute carbon metrics category and are as such not affected by exchange rate and inflation effects.

The TCFD recommends its members and clients to use the WACI metric as the optimal method to disclose their financial carbon intensity[6]. Therefore, in our study the WACI can be seen as our base model. As a consequence, various large financial companies have adopted the TCFD carbon footprint methodology, e.g. J.P. Morgan, Morgan Stanley, Aviva and HSBC. For the purposes of this study, the following sub-sections will describe and compare the first three metrics mentioned above – the WACI, CFP, and CI metrics.

2.2.1 Weighted Average Carbon Intensity (WACI)

The first and most important metric is the WACI, as it is the metric which serves as the recommended method by which an investor should disclose their respective financial carbon intensity. Going forward, the WACI serves as our base statistic to describe in detail how relative carbon footprint metrics are affected by exchange rates and inflation. The WACI is determined as follows (TCFD, 2017):

$$WACI_{i,t} = \sum_{j}^{n} \left(\frac{current\ value\ investment_{i,j,t}}{current\ value\ portfolio_{i,t}} * \frac{issuer's\ Scope\ 1\ and\ Scope\ 2\ GHG\ emissions\ (in\ tonnes)_{\ i,j,t}}{issuer's\ revenue\ (in\ millions)_{i,j,t}} \right) \quad (1)$$

[6] The current global carbon disclosure structure lacks a consistent taxonomy, and therefore various terms are often used interchangeably to refer to the same thing. The WACI sometimes is called a relative carbon footprint. This study will be using the term WACI from here on out.

where the left fraction represents the portfolio *weight* – i.e. the weight of an investment in the total portfolio of investments – and the right fraction corresponds to the *carbon efficiency* of the issuer of that investment. The WACI can be determined at an institution level, e.g. based on the portfolio of a specific bank, insurance company or pension fund. In this report, we determine the WACI – and the other relative carbon disclosure metrics – at the sectoral level. That implies that for each sector *i* – i.e. insurers or pension funds – we consider the investment in issuer *j* (e.g. equity or bond issuing companies) at calendar year *t*. The summation over *j* therefore implies that the computation should be made for each investment and then added over all *n* investments in a portfolio of investments held by the sector *i*. The terms *weight* and *carbon intensity* will be used throughout the study to refer to these two fractions that together determine the WACI. The carbon intensity is a relative measure since the greenhouse gas (GHG) emissions of a company are taken relative to their respective revenue. By accounting for the revenue, one is able to measure how efficiently a company is able to produce relative to how much they emit.

The WACI is prone to reflect exchange rate effects. With the exception of the emissions in the numerator of the carbon intensity, the remaining three variables are expressed in monetary terms. Given how the WACI is defined, and since the unit of the metric is dependent on a currency, it is prone to reflect exchange rate fluctuations. The two formulas (2a) and (2b) below show that the choice of the currency influences the WACI. While the currency effect drops out in the left-hand side of the formula, the choice for a currency influences the right-hand side of the formula.

$$\sum_{j}^{n}\left(\frac{current\ value\ investment_{i,j,t}\ (€)}{current\ value\ portfolio_{i,t}\ (€)} * \frac{issuer's\ Scope\ 1\ and\ Scope\ 2\ GHG\ emissions_{i,j,t}}{issuer's\ revenue_{i,j,t}\ (€)}\right) (2a)$$

$$\sum_{j}^{n}\left(\frac{current\ value\ investment_{i,j,t}\ (\$)}{current\ value\ portfolio_{i,t}\ (\$)} * \frac{issuer's\ Scope\ 1\ and\ Scope\ 2\ GHG\ emissions_{i,j,t}}{issuer's\ revenue_{i,j,t}\ (\$)}\right) \quad (2b)$$

The exchange rate effect is relevant when measuring the developments in the WACI over time. The portfolio of financial institutions often consists of equities and bonds that are issued in different currencies. That is, the currencies of the different issuers *j* are often not similar. By using an exchange rate time series to convert the different currencies into one currency at every point in time *t*, an exchange rate effect will appear when considering the WACI over time.

This effect becomes more apparent when the exchange rate between a dominating currency and the denoted currency fluctuates a lot. When a large share of the investments in a portfolio are denoted in a currency (the "dominating currency") that differs from the

currency used in the unit, the exchange rate effect becomes larger. By contrast, the exchange rate effect is not an issue if a particular denoted currency is for instance pegged to the dominating currency.

On top, inflation rate effects may impact the WACI if a portfolio's WACI is observed over time. One needs to adjust the monetary variables (current value investment, current value portfolio, and issuer's revenue) for inflation relative to a certain base year. This has to be done in order to properly describe how the portfolio's actual WACI is evolving in 'real' terms. The reasoning follows the same logic as adjusting nominal GDP for inflation, or house price indexes, over time.

2.2.2 Carbon Footprint (CFP)

In contrast to the WACI, the CFP first relates the investment value to the issuer's enterprise value. We take the enterprise value[7] instead of the market capitalization (as proposed by the TCFD if one considers the equity portfolio) since in our study we consider both equities and bonds. Hence, the CFP is calculated as follows:

$$CFP_{i,t} = \frac{\sum_j^n \left(\frac{current\ value\ investment_{i,j,t}}{issuer's\ enterprise\ value_{i,j,t}} * issuer's\ Scope\ 1\ and\ Scope\ 2\ GHG\ emissions_{i,j,t} \right)}{current\ portfolio\ value\ (in\ millions)_{i,t}} \quad (3)$$

While not presented that way by the TCFD, the only real difference between the CFP and the WACI is the metric that is used to normalize the carbon emissions. The summation in Equation (3) sums all investments present in a portfolio, at each time period considered separately and therefore the sum is independent of time. Mathematically, it is equivalent to divide by a constant term inside, or outside a summation. In this context, the constant term is the *current value of the portfolio.* Therefore, by rearranging the terms in Equation (3), the carbon footprint metric can be rewritten as:

$$CFP_{i,t=} \sum_j^n \left(\frac{current\ value\ investment_{i,j,t}}{current\ value\ portfolio\ (in\ millions)_{i,t}} * \frac{issuer's\ Scope\ 1\ and\ Scope\ 2\ GHG\ emissions_{i,j,t}}{issuer's\ enterprise\ value_{i,j,t}} \right) \quad (4)$$

whereas the main difference between Equation (1) – the WACI – and Equation (4) is the choice of indicator with which to normalize emissions. The CFP normalizes emissions by using the investee's enterprise value (a stock variable), while the WACI uses the issuers' revenue (a flow variable).

[7] More specifically, we use the Enterprise Value (EV) and not the Enterprise Value Including Cash (EVIC), due to limited availability of the latter.

The so-called CFP is mathematically more equivalent to a Weighted Average Carbon Intensity (WACI). While the TCFD uses market capitalisation to normalise emissions in the CFP, this study uses enterprise value in order to combine equity with corporate bonds in one metric. This discrepancy however, does not influence the argument made since it is independent of the choice of the denominator – our results apply to any *relative* carbon disclosure metric. Also, note that the intended purpose of the CFP is to assess emissions from an ownership perspective – the numerator in Equation (3) in fact is equal to the absolute carbon emissions a financial institution 'owns' (i.e. is responsible for) through its ownership of a percentage of the equity (and bonds) of a particular issuer *j*. However, due to the normalization of these absolute emissions (i.e. dividing by the denominator in Equation (3)), and the subsequent rearranging of terms in Equation (4), it is clear that the CFP metric can at the same be interpreted as a 'carbon efficiency' that is based on a stock variable (with portfolio weights similar to the WACI).

A disadvantage of the CFP, compared to the WACI, is that it does not consider the added economic value – i.e. the revenue – of the issuer. This is a limitation, since normalizing by the issuer's revenue allows to measure how efficiently a company is able to produce relative to how much they emit. On top, similar to the WACI, the CFP is prone to reflect exchange and inflation rate effects.

2.2.3 Carbon Intensity (CI)

Lastly, we consider the CI metric. Similar to the CFP metric, enterprise value is used instead of market capitalization in order to be able to combine equity with the corporate bonds holdings. The CFP uses the portfolio value as a weight, while the CI uses the issuer's revenue as a weight to normalize the value of the investor's portfolio. The CI is calculated as follows:

$$CI_{i,t} = \frac{\sum_j^n \left(\frac{current\ value\ investment_{i,j,t}}{issuer's\ enterprise\ value_{i,j,t}} * issuer's\ Scope\ 1\ and\ Scope\ 2\ GHG\ emissions_{i,j,t} \right)}{\sum_j^n \left(\frac{current\ value\ investment_{i,j,t}}{issuer's\ enterprise\ value_{i,j,t}} * issuer's\ revenue\ (in\ millions)_{i,j,t} \right)} \quad (5)$$

A disadvantage of this metric, compared to the WACI – the measure that also takes into account an issuer's revenue – is that the measure is more complex, and thus may be more difficult to communicate and interpret. Similar, to the CFP it aims to offer insights from an ownership perspective, and does this both for the issuer's emissions as for the issuer's revenue that is used to normalize the metric. Similar to the WACI and the CFP, the measure is affected by exchange and inflation rate effects.

3. Methodology and data

3.1 Data

This study relies on data of Dutch pension funds and insurance companies, provided by the Dutch Central Bank. The data contains information on the holdings of assets of individual institutions and is confidential. The Dutch pension fund sector has a large volume of assets under management of about EUR 1.554 billion (2019Q4). This equals 191% of Dutch GDP. Dutch insurers have fewer assets under management, adding up to a total of EUR 515 billion (2019Q4), equalling 63% of Dutch GDP. Given their size, these sectors are important providers of funding to the real economy. The investment decisions by these parties therefore have consequences for the access to funding for sustainable initiatives or carbon intensive sectors. Pension funds and insurance companies also invest via investment funds that manage asset portfolios on behalf of these parties. Our data covers the investments via investment funds, where available. In total we cover 40.2% and 29.8% of the equity and corporate bond asset classes of the pension fund's and insurer's portfolios respectively in 2019Q4. The coverage for equities is higher than for corporate bonds; 49.0% and 49.6% (equities) versus 17.8% and 22.2% (corporate bonds) for pension funds and insurance companies respectively.[8]

Emission data, and issuing companies' revenue and enterprise value are obtained from Refinitiv ESG. Refinitiv ESG reports the variables for each company that has listed equity, on an annual basis, by its respective International Securities Identification Number (ISIN) code. These ISIN codes are used to collect company information (e.g. emissions and revenue data) and are then merged to the asset exposures of pension funds and insurance companies using the company identifier from the Security Holding Statistics (SHS).

In this study, metrics are calculated based on scope 1 and scope 2 emissions, in line with the current TCFD's recommendation. Table 1 shows the definitions of the scope 1, scope 2 and scope 3 emissions. Scope 3 emissions are the most broad category and therefore hardest to accurately quantify without a harmonized framework in place. Refinitiv also reports scope 3 emissions. However, the accuracy of the data is questionable and therefore will not be incorporated in the analysis, due to two main reasons. First, to this day companies are free to determine the boundaries of their supply chain. Second, if several actors in a supply chain report scope 3 emissions, then some of these emissions are likely to be double counted (Warmerdam et al., 2019). Therefore, we follow the TCFD's recommendation here (TCFD, 2017; Linthorst & Schenkel, 2017). Note that although the inclusion of scope 3 emissions is essential to determine actual carbon intensity levels, it does not influence the argument made that inflation and

[8] Non-positive investment holdings are excluded, as well as holdings with an unknown currency.

exchange rate effects should always be accounted for when reporting relative carbon disclosure metrics (irrespective of to the scope(s) that is (are) considered).

Table 1: Definition of Scope 1, 2, 3 emissions

Scope	Definition
Scope 1	Direct company's emissions, e.g. emissions from a production plant that the company owns.
Scope 2	Indirect company's emissions produced through their energy consumption, e.g. heating, cooling, steam and electricity production that are outsourced to a third party, but are used by the main company for its activities.
Scope 3	Indirect company's emissions that occur throughout their production chain – both up and downstream. These can include emissions emitted during the production of purchased inputs, employees commuting, the refrigeration of a beverage in a store before it's sold.

Source: GHG (2011)

Remaining macro-economic variables, i.e. the inflation and exchange rate, are obtained from IMF, ECB, World Bank and Refinitiv.[9] Most of the exchange rates are obtained from the ECB Statistical Data Warehouse. For the ones that are not available, data was extracted from Refinitiv. Inflation rates – based on the Consumer Price Index (CPI)[10] – are obtained from the IMF, and supplemented with data from the World Bank.

All data is obtained over the period 2012-2019 and we use a balanced dataset. The constructed dataset is a panel dataset on an ISIN-year level. We remove ISINs from the dataset in case data is missing for specific years. The main reason for doing so is that we are interested in the development of the carbon metrics over time. As such, we would like to avoid any fluctuations over time that may be caused by missing data in specific years. We do however test for the robustness of our conclusions by performing the same analysis with an unbalanced dataset, where similar findings have been observed.[11]

[9] Data on exchange rates is missing for the Tunisian Dinar (TND). Inflation rates could not be obtained for the Bermuda Dollar (BMD). We excluded observations that report in Argentinian peso (ARS), because of hyperinflation. In terms of coverage, the impact of the missing data on the total coverage is negligible.

[10] There are more inflation metrics, such as the Producer Price Index (PPI) or the Gross Domestic Product (GDP) Deflator. The GDP and CPI inflator have the highest coverage. There are two distinct differences between the GDP and CPI deflators that have ultimately led to the latter index being chosen as the statistic by which inflation is controlled in this study (Church, 2016). First, the GDP deflator takes into account government expenditures. Second, the CPI takes into account imported goods. As will be described in the following section, the analysis will only be using listed equity and corporate bonds, and therefore government expenditures are likely to be of little importance to companies. Imported goods, however, are usually part of a company's supply chain and therefore are more relevant for the analysis. For these two reasons, the choice was made to use the CPI deflator to adjust the carbon metrics for inflation.

[11] Using an unbalanced dataset has an impact on the level of the relative carbon disclosure metrics. However, the impact of exchange rate and inflation effects remains.

3.2 Methodology

3.2.1 Proposed methodological adjustments to carbon metrics

This study proposes to adjust the monetary values for exchange rate and inflation effects. While the methodology advocated by the TCFD as summarised above does not adjust monetary values for exchange rate and inflation, the Intergovernmental Panel on Climate Change (IPCC) offers an approach to convert currencies and to account for inflation (Krey et al., 2014). This method proposes to normalise all currencies across space and time by using a fixed currency and this can be best explained by using an example. Suppose one wants to convert 2019 U.S. Dollars (USD) to 2012 Euros (EUR). This will require a two-step procedure:

1. *Deflate the 2019 USD to its 2012 equivalent using an appropriate deflator (e.g. Consumer Price Index).*
2. *Convert the 2012 USD to 2012 EUR using the constant 2012 spot market exchange rate between the two currencies.*

By using a constant exchange rate (i.e. at one point in time), one can both address the inflation and exchange rate effect in once. In the example above, any currency can be expressed to a constant 2012 EUR exchange rate. The main advantage is that it simultaneously attempts to control for both effects – it addresses the inflation effect by transforming a monetary variable from *nominal* to *real*, while also controlling for the exchange rate effect because it uses an exchange rate fixed in time. Using a constant exchange rate eliminates the effect because there are no fluctuations, as present with an exchange rate time series. Regardless of the method, there are nevertheless limitations, for instance when a currency experiences hyperinflation and the accuracy of the reported statistics is questionable. This is an issue however that does not have a viable solution in the literature and is a general, unavoidable limitation of comparing monetary values over time. In this report, we therefore remove the investments denoted in currencies that experienced hyperinflation. It is to be noted that the two-step procedure outlined above, in theory is equally valid if the steps are reversed (Turner et al., 2019).[12]

[12] We however have a preference for first correcting for inflation because investment and company revenues should be adjusted for the country-specific inflation of where they are located. After all, a country experiences inflation in the country in which it produces its goods, and is not affected by the inflation rates of the country's currency in which one desires to denote the WACI.

3.2.2 Other methodological choices

In this report we focus on the WACI, but we perform the same analysis for the other relative carbon disclosure metrics – i.e. the CFP and CI – as well. We regard the WACI as our base model, since this is a frequently recommended method by which an investor should disclose their respective financial carbon intensity. For robustness, we however conduct the same analysis for the other relative carbon disclosure metrics, i.e. the Carbon Footprint (CFP) and Carbon Intensity (CI) metrics. This analysis is presented in section 4.3.

This report also inspects whether the choice of a base year influences the results. In our base model we regard the year 2012 as the base year, but for robustness we compare the results where 2019 is taken as the base year. Changing the base year to 2019 entails inflating, as opposed to deflating, monetary values, and using the fixed 2019 exchange rate.

In addition to these methodological choices, we also expand our analysis in two ways, i.e. i) by analysing the equity and bond portfolio separately and ii) by investigating what drives the observed greening of the portfolios. Regarding the latter, we analyse the carbon intensity – using the WACI - of the portfolio in case the insurance and pension fund sector would have followed a passive investment strategy (i.e. same portfolio allocation over the years 2012-2019). The outcomes of these two additional analyses are presented in Appendix.

4. Portfolio analysis

Table 2 below summarises the main analysis conducted in the study. For each relative carbon footprint metric defined by the TCFD, table 2 below shows the percentage change of the respective adjusted and non-adjusted metric between 2012-2019, for the Dutch pension fund and insurance sectors. For instance over the period 2012-2019, the pension funds' unadjusted WACI showed a decrease of 34.4%, while the adjusted WACI decreased by 24.1%. Therefore, the adjustment shows that 10.3 percentage points of the greening was 'non-real'.

Table 2: Average carbon metrics by sector, adjusted and unadjusted

This table shows the adjusted and unadjusted average carbon metrics by sector. 2012 is taken as the base year for the adjusted metrics.

	Pension Funds		**Insurance Companies**	
Metric	Unadjusted	Adjusted	Unadjusted	Adjusted
WACI	34.4%	24.1%	31.0%	23.7%
CI	23.9%	13.6%	22.5%	15.1%
CFP	52.4%	44.9%	51.8%	46.7%

This section of the study is structured in three separate subsections. Section 4.1 presents the standard, unadjusted WACI for both sectors considered and highlights the importance of the choice of currency used to denominate the relative carbon footprint. Section 4.2 presents the adjustment this study proposes by using the WACI, and decomposes the effect of the adjustment for each sector by showing how it is dependent on the currency portfolio composition. Section 4.3 shows results for a change of base year and offers more detailed results for the Carbon Footprint (CFP) and Carbon Intensity (CI).

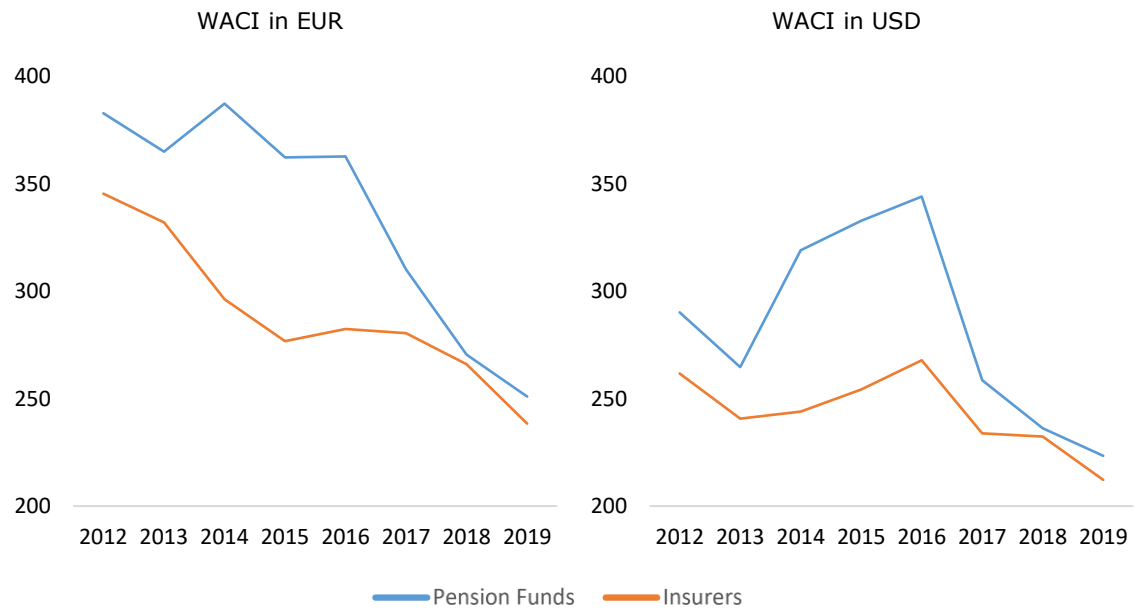
4.1 The unadjusted WACI for pension funds and insurers

The choice of currency to denote the WACI influences the level and its evolution over time. Figure 1 below depicts the unadjusted WACI for the pension fund and insurer sectors over the period 2012-2019, following TCFD (2017). The left panel shows the WACI denoted in EUR, whereas the right panel portrays the same WACI in USD. The figure highlights the importance of the choice of currency in which to denote the WACI, and furthermore shows one of the barriers to consistent international comparability. By comparing the two graphs in Figure 1, one can see that the currency in which the WACI is denoted affects the level and trend it portrays over time. Evidently, no real change has occurred between the two graphs – the emissions released into the atmosphere are the same in both cases (Dijk, 2019). This poses a challenge to create a globally harmonized framework.

Conclusions made regarding the evolution of the WACI over time would be different depending on the currency used to denote the WACI, as shown by the example in Figure 1. Over the considered time period, in both currencies the pension fund's WACI was higher than that of the insurers. From 2012 to 2019 the pension fund sector appears to reduce their WACI by 34.4% when denoted in EUR, while the decrease corresponds to 23.0% when the WACI is denoted in USD. Similarly, the insurance sector reduced their WACI by 31.0% in EUR, and by 18.9% in USD. While both sectors show a larger percentage decrease in their WACIs when they are denoted in EUR, the level of both sectors' WACIs is monotonically lower in USD. The following section delves into the impact the inflation and exchange rate adjustments have on the WACI time series shown in Figure 1.

Figure 1: Unadjusted WACI for Dutch pension fund and insurance sectors

The figure on the left shows the WACI expressed in EUR for both pension funds and insurance companies, while the figure on the right shows the WACI expressed in USD for both sectors. The formula in Equation (1) is used.



4.2 Inflation and exchange rate effects

When the WACI is adjusted for inflation and exchange rate fluctuations, one can observe the *real* improvement of the WACI over time. Figure 2 depicts the adjusted and unadjusted WACIs for both sectors considered in this study (left axis), and the USD-EUR exchange rate (right axis). The figure will be used to explain the impact of the fluctuating exchange rate on the WACI.

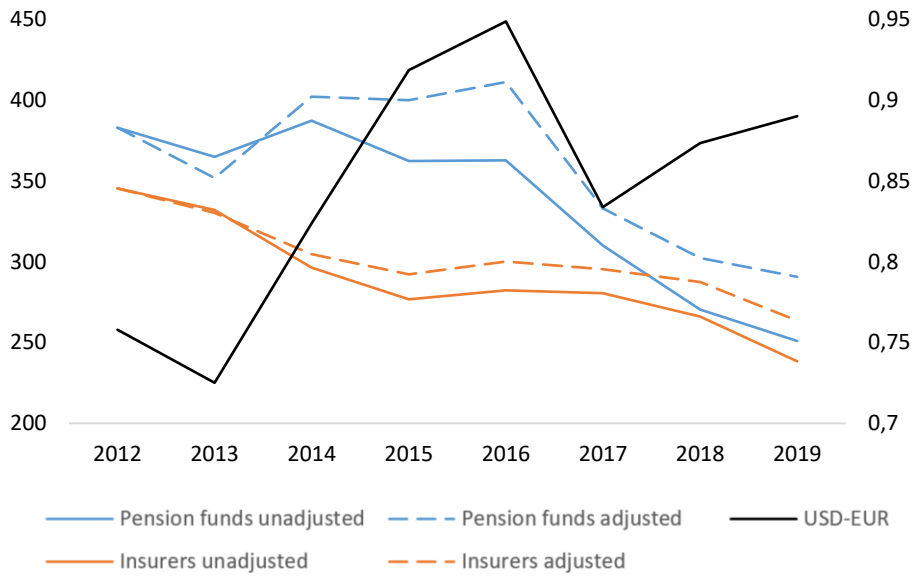
The observed differences between the adjusted and unadjusted WACI are quite substantial. For pension funds, over the period 2012-2019 the unadjusted WACI decreases with 34.4% (from 382.9 to 250.9) while the adjusted WACI decreases with 24.1% (from 382.9 to 290.6). The difference is 10.4 percentage points, and thereby around one-third of the observed "greening" in the unadjusted WACI is not-real greening. For insurers, the unadjusted WACI decreases with 30.1% while the adjusted WACI decreases with 23.7%, leading to a difference between the adjusted and non-adjusted WACIs of 7.3 percentage points over the period 2012-2019. Here, more than one quarter of the observed "greening" in the unadjusted WACI is 'non-real'.

Our proposed adjustment affects Dutch insurers and pension funds in different ways, which is by and large explained by the differences in portfolio compositions between the two sectors. Insurers predominantly hold investments in EUR [71.6% in EUR and 17.5% in USD in 2019Q4], which leads to the inflation adjustment applied to investments denoted in EUR to have the largest weight in the impact of the adjustment. By contrast, pension funds mostly invest in USD [44.9% USD and 23.6% EUR in 2019Q4], while the WACI is denoted in EUR. In this context, if one wants to denote a WACI in EUR[13], this leads to the applied adjustment being more sensitive to the EUR-USD exchange rate. Since the USD dominates pension fund portfolios, fluctuations in its exchange rate to the EUR are absorbed by the unadjusted WACI.

[13] Or any other non-USD currency for that matter.

Figure 2: Insurers' and pension funds' adjusted and non-adjusted WACIs

The figure shows the adjusted and non-adjusted WACIs for pension funds and insurers (left axis), and the USD-EUR exchange rate (right axis).



A fluctuating exchange rate between the largest currency in a portfolio and the currency used to denominate the WACI has an impact on the unadjusted WACI, when considering its evolution over time. The adjusted WACI is expressed in one currency – in this analysis, the EUR. As the largest currency in the pension fund portfolio – in this case the USD – appreciates, asset positions and company revenues originally denoted in USD become larger in value when they are converted into EUR, even if the *real* monetary value remains unchanged. A larger revenue in the denominator of the WACI, in turn, reduces the value of the carbon *efficiency* (i.e. the right fraction of the formula). In other words, as the USD appreciates relative to the EUR, the standard WACI expressed in EUR appears to decrease, *ceteris paribus*. Similarly, as the USD depreciates the standard WACI expressed in EUR will appear to be higher because the investments originally denoted in USD will be worth less in EUR, and therefore emissions will be divided by a smaller value. Hence, if the USD depreciates relative to the EUR, the adjusted WACI will be lower relative to the standard WACI, and vice-versa. This logic holds for all currency exchange rates to the EUR, however the smaller the total value of a particular currency in the portfolio, the smaller its effect will be on the adjustment. Generally, it is the exchange rate of the largest currency which will dictate the trend, while fluctuations in smaller currencies will either amplify or offset the largest currency's exchange rate effect. Finally, the exchange rate effect increases as the exchange rate becomes more volatile.

Figure 2 shows that the evolution of the WACI is driven by the changes in the USD-EUR exchange rate. As mentioned before, pension funds mostly invest in USD, while insurers predominantly hold investments in EUR. The impact of the USD-EUR exchange rate is therefore mainly visible for pension funds, in Figure 2. As the USD depreciated to the EUR from 2012 to 2013, the pension funds' adjusted WACI is lower than the standard WACI. Similarly, as the USD appreciated over the period 2013 – 2016, the exchange rate adjusted WACI becomes higher than the standard WACI due to the reasoning provided in the previous paragraph. Moreover, the distance between the adjusted and non-adjusted WACIs increases over this time period. The same reasoning can be applied for the remaining time horizon. From 2016 – 2017, the USD depreciated to the EUR, and the distance between the adjusted and non-adjusted WACIs decreased. By contrast, from 2017 – 2019 the USD appreciated to the EUR, and as a result the exchange rate adjusted WACI diverges from the standard WACI. Overall, the difference between these two variations for pension funds in 2019 is 10.4 percentage points.

4.3 Comparing metrics and specifications

The following section consists of two subsections. First, the impact of the adjustment is shown for the other two relative carbon footprints – the Carbon Footprint (CFP) and the Carbon Intensity (CI). Second, a robustness check is conducted where the base year is changed from 2012 to 2019, to show that the choice of base year is of limited influence to the adjustment.

4.3.1 Carbon Footprint (CFP) and Carbon Intensity (CI)

Similar findings as shown for the WACI hold for alternative relative carbon footprints, such as the TCFD's CFP and CI metrics. While the exact evolution of the CFP and CI metrics differ to the WACI's, the proposed adjustment has a similar impact.

Figure 3 below shows the adjusted and non-adjusted insurers' and pension funds' CFP. We find that the unadjusted CFP of insurers decreased by 51.8%, while the adjusted CFP decreased by 46.7% from 2012 to 2019 – a difference of 5.1 percentage points. The unadjusted CFP for pension funds improved by 52.4% from 2012 to 2019, while the adjusted CFP improved by 44.8% - a percentage point difference of 7.6.

Figure 3: Insurance and pension fund sectors' adjusted and non-adjusted CFPs

This figure shows the adjusted and non-adjusted CFPs for pension funds and insurers, based on the formula in equations (3) and (4).

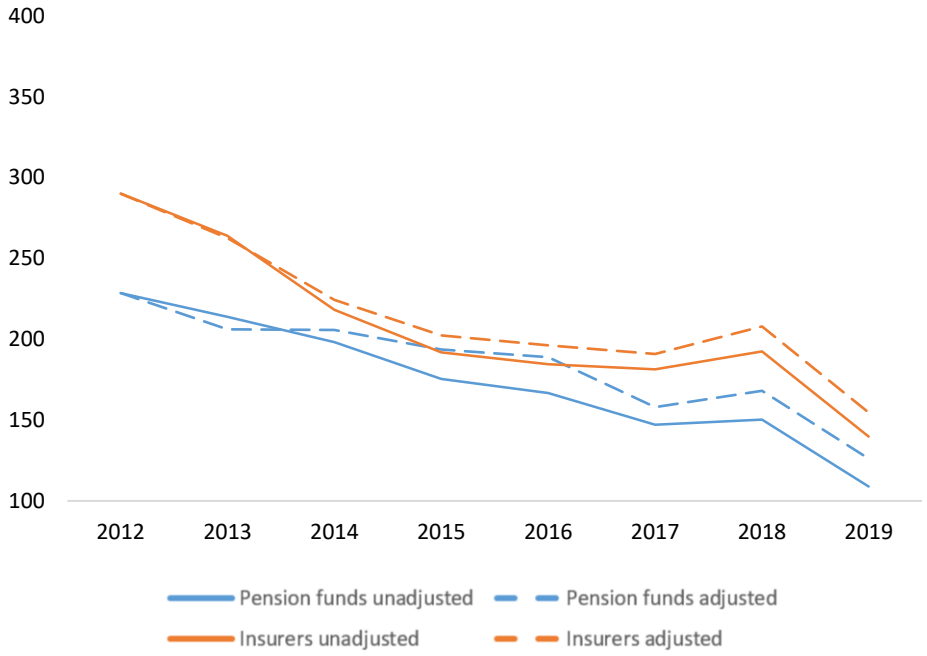
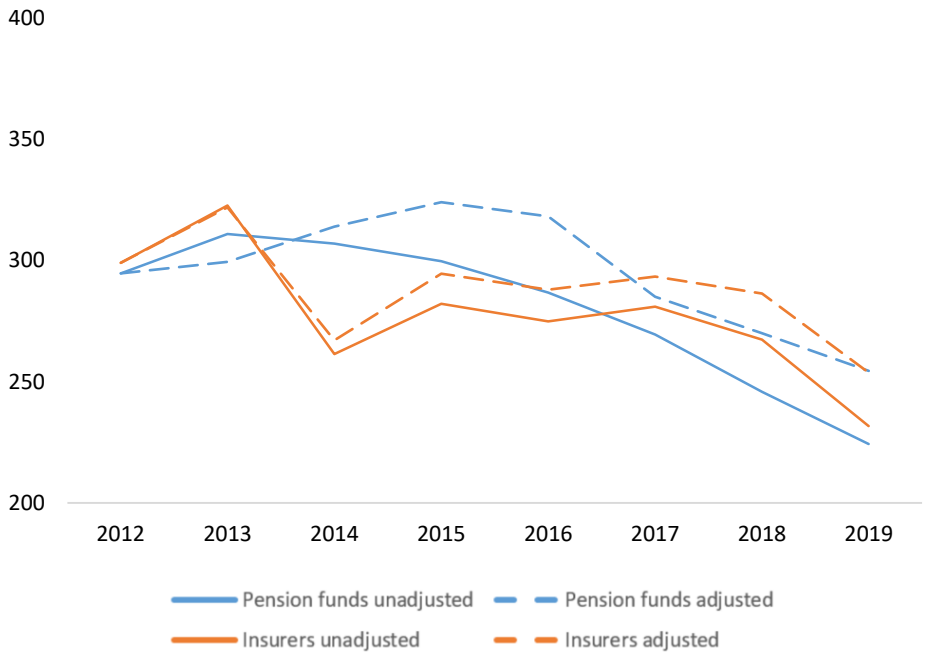


Figure 4 below shows the adjusted and non-adjusted CI metrics for both insurers' and pension funds' sectors. For the insurers' CI, the unadjusted version decreased by 22.5% and the adjusted CI decreased by 15.1% from 2012 to 2019 – leading to a difference of 7.4 percentage points. Similarly, for the pension funds' CI, we find that the unadjusted CI decreased by 23.9%, while the adjusted CI showed a greening of 13.7% and therefore the adjustment removes 10.2 percentage points of 'non-real' greening. The adjustment therefore has a similar effect as it had for the WACI, where the difference between the unadjusted and adjusted versions was 7.3 and 10.4 percentage points for the insurers and pension funds respectively.

Figure 4: Insurance and pension fund sectors' adjusted and non-adjusted CIs

This figure shows the adjusted and non-adjusted CIs for pension funds and insurers, based on the formula in equation (5).



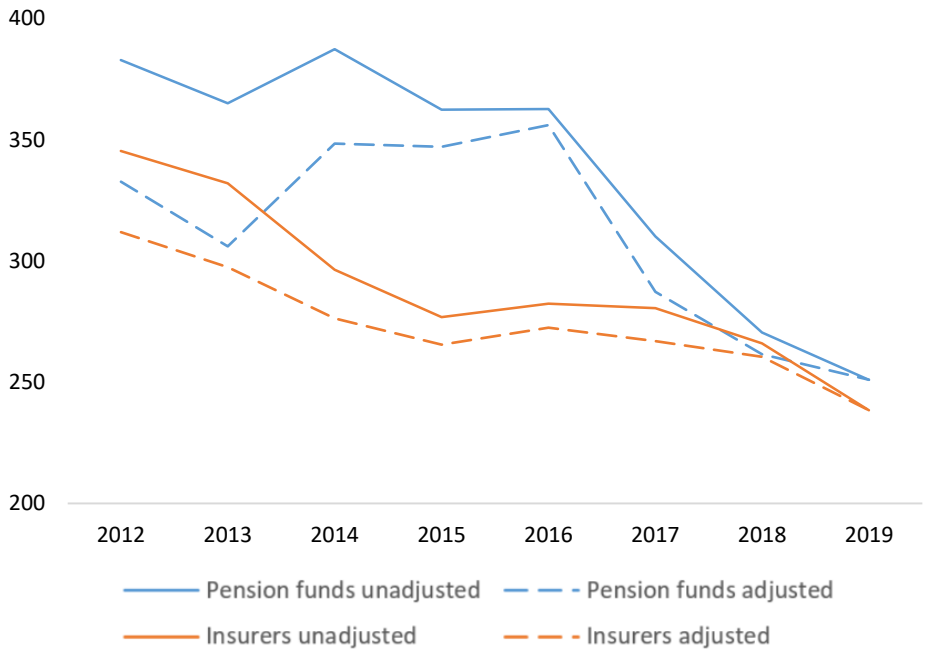
If one wants to compare portfolios, different conclusions can be drawn based on which relative carbon metric is used. If one uses the WACI metric to compare the sustainable performance over time of the asset portfolios of pension funds and insurers, one could conclude that, on average, insurers are more efficient and are emitting less greenhouse gases per EUR invested/revenue. However, the contrary conclusion can be made if one makes use of the CFP metric – pension funds are, on average, more 'green'. While the two are distinct metrics, the only difference between the CFP and WACI metrics is that the former uses *enterprise value* to normalise company emissions, while the latter uses *revenue* to normalise emissions [see section 2.2.2, equations (1), (3) and (4)].

4.3.2 Changing base year

The inflation and exchange rate adjustment is robust to a change of the base year. The following section shows the effect of the adjustment when the base year is changed from 2012 to 2019. The adjustment is robust to changes of the base year. So far, this study has deflated monetary variables to 2012 as a base year. In this section, figure 2 depicted in section 3.2 is replicated by using 2019 as the base year. In this context, rather than deflating monetary values to 2012, all monetary values are inflated to 2019. Figure 5 below shows the result – the point in common between the adjusted and non-adjusted WACIs now is 2019 instead of 2012. For pension funds, the difference between the unadjusted WACI and adjusted base 2012 WACI is 10.4 percentage points, while the difference between the unadjusted WACI and the adjusted base 2019 WACI is 9.9 percentage points - a difference of 0.5 percentage points. Similarly for insurers, the difference between the unadjusted WACI and the adjusted base 2012 WACI is 7.3 percentage points, while the difference between the unadjusted WACI and the adjusted base 2019 WACI is 7.4 percentage points - a difference of 0.1 percentage points. A final observation is that the adjusted WACI is positioned below the unadjusted WACI for both sectors and can be seen as a rotation of the adjusted WACI with base year 2012.

Figure 5: Insurance and pension fund sectors' adjusted and non-adjusted WACIs, base year 2019

The figure shows the adjusted and non-adjusted WACIs for pension funds and insurers, using 2019 as the base year.



5. Conclusion

DNB has the ambition to contribute to the development of robust climate change statistics to measure both risk and impact. Improving our confidence in backward-looking metrics such as carbon disclosure metrics, enables central banks and supervisors to determine whether the financial sector is on the right track toward reaching the target of the Paris Agreement, and ensures that forward-looking tools such as scenario analysis and stress tests use better historical information to estimate the risks facing the financial sector.

This report shows that adjusting relative carbon disclosure metrics for inflation and exchange rate fluctuations makes a significant difference to the level and dynamics of these metrics over time. From 2012 to 2019, the standard – i.e. unadjusted – WACI for the Dutch pension fund and insurance sector decreased on average by 34.5% and 31.0% respectively. The adjusted WACI – i.e. the WACI adjusted for inflation and exchange fluctuations – however shows an improvement of only 24.1% and 23.7% respectively over the same period. While the standard WACI is valid to observe and compare portfolios at a certain point in time, this report shows that in order to meaningfully interpret and compare the WACI over a particular time horizon, it is necessary to correct for inflation and exchange rate fluctuations. As the results are significant and similar for other relative carbon disclosure metrics, DNB recommends using adjusted relative carbon disclosure metrics instead of unadjusted metrics.

Adjusting relative carbon disclosure metrics for inflation and exchange rate effects take us a small step further, but there are more issues to be resolved. Other important unresolved issues include (carbon) emission data coverage, the lack of (consistency in) corporate disclosures of Scope 3 emissions, and the fragmented landscape of voluntary standard setting organizations, third-party (commercial) data providers, and the differences in their methods and applications to provide (actual or modeled) carbon disclosure metrics and the emissions data these are based upon. As long as these issues remain unresolved, DNB recommends to clearly communicate data coverage, models and assumptions of carbon disclosure metrics used in reporting of non-financial and financial corporations, and to report on multiple backward and forward-looking indicators, as well as absolute and relative carbon disclosure metrics until harmonized global standards are in place.

Corporate and financial sector disclosures on climate-related information should improve in quantity, quality and consistency. Credible and comparable sustainability information, complementing the financial information already available, should be readily available for all market participants, shareholders and other stakeholders to offer meaningful insights in the role the financial sector plays in reaching net-zero emissions by 2050. The metrics that the financial sector is able to report are only as reliable as the corporate disclosures they

are built upon. Current efforts by the IFRS foundation, a key global standard setting body for corporate reporting, trigger expectations that a global sustainability standard will soon be developed and take effect at some time in the future. Other important efforts that push forward the goal of reaching a harmonized global standard are for instance the EU's Non-Financial Reporting Directive (NFRD), the EU's Regulation on the sustainability-related disclosures in the financial services sector (Regulation 2019/2088), and international organizations such as the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), and the Sustainability Accounting Standards Board (SASB). Until a harmonized global standard is in place however, the Network for Greening the Financial System (NGFS), and its ever-expanding group of central banks and supervisors, can for instance assist in ensuring that best practices are shared and applied consistently among its global membership.

We also identify some areas for further research in this field. The impact of the inflation and exchange rate effect should be tested for other asset classes (e.g. sovereign bonds, loans, and mortgages) and other financial sectors. The reduction in sustainability improvements in this report are mainly driven by the adjustments for inflation, and to a lesser extent by exchange rate effects. When exchange rate effects have the upper hand and/or deflation occurs in a particular dataset, adjusted metrics can in fact show larger sustainability improvement compared to their unadjusted counterparts. The direction of the results is thus very much dependent on the geographical composition of the portfolio and the time period that is studied. Other avenues for further research include different ways to adjust for inflation when considering multinationals (i.e. multiple CPIs based on geographical information on global activities), and for instance taking into account dividends (for assets) and coupons (for bonds) when computing a relative carbon footprint. DNB will continue this and other research on the development of robust climate change statistics.

6. Literature

Aviva. (2019). *Aviva's Climate-Related Financial Disclosure 2019: Metrics and Targets Summary.* (pp. 1-4, Climate-Related Financial Disclosure 2019).

Buchner, B., Clark, A., Falconer, A., Macquarie, R., Meattle, C., Wetherbee, C., and Tolentino, R. (2019). Global Landscape of Climate Finance. Climate Policy Initiative.

Church, J. D. (March 2016). Comparing the Consumer Price Index with the gross domestic product price index and gross domestic product implicit price deflator. *Monthly Labor Review,* U.S. Bureau of Labor Statistics, https://doi.org/10.21916/mlr.2016.13.

Dijk, J. (2019, October 4). Insurers have relatively sustainable equity investments. *Statistical News Release DNB*. Retrieved from https://www.dnb.nl/en/news/news-and-archive/Statistischnieuws2019/dnb385843.jsp

EU TEG. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance* (pp. 1-67, Tech.).

Eurostat. (2013). European system of accounts: ESA 2010. Luxembourg: Publications Office of the European Union.

Harvey, F. (2019). *Quarter of World's Biggest Firms 'Fail to Disclose Emissions'.* The Guardian, Guardian News and Media, 9 July 2019. https://www.theguardian.com/environment/2019/jul/10/quarter-of-worlds-biggest-firms-fail-to-disclose-greenhouse-gas-emissions

Greenhouse Gas (GHG), (2011). GreenHouse Gas Protocol. Product Life Cycle Accounting and Reporting Standard. https://ghgprotocol.org/product-standard

IPCC (2018). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* In Press.

J.P. Morgan Asset Management (2020). Choosing a climate risk metric. Retrieved July 15, 2020, from https://am.jpmorgan.com/content/dam/jpm-am-aem/emea/regional/en/insights/portfolio-insights/choosing-a-climate-risk-metric.pdf

Lagarde, C. (2020). Speech: Climate Change and the Financial Sector. COP 26 Private Finance Agenda, 27 February 2020, London. www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200227_1~5eac0ce39a.en.html

Krey V., O. Masera, G. Blanford, T. Bruckner, R. Cooke, K. Fisher-Vanden, H. Haberl, E. Hertwich, E. Kriegler, D. Mueller, S. Paltsev, L. Price, S. Schlömer, D. Ürge-Vorsatz, D. van

Vuuren, and T. Zwickel (2014). Annex II: Metrics & Methodology. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Le Treut, H., R. Somerville, U. Cubasch, Y. Ding, C. Mauritzen, A. Mokssit, T. Peterson and M. Prather (2007). Historical Overview of Climate Change. *In: Climate Change 2007: The Physical Science Basis*.

Linthorst, G., and Schenkel, M. (2017). Paving the way towards a harmonised Carbon Accounting Approach for the Financial Sector (pp. 1–48). The Netherlands: Partnership Carbon Accounting Financials.

Morgan Stanley Capital International (MSCI) (2020, April 30). MSCI Index carbon footprint metrics. Retrieved July 20, 2020, from https://www.msci.com/documents/1296102/6365510/MSCI-IndexCarbonFootprintMetrics-cfs-en.pdf/de79973f-2704-4987-bfb0-391e27577b47

NGFS (April, 2019a). A Call for Action: Climate Change as a Source of Financial Risk (pp. 1–42).

PCAF Netherlands. (2019). Accounting GHG emissions and taking action: harmonised approach for the financial sector in the Netherlands (pp. 1–108).

Robeco (2020). *Climate Change Policy* (pp. 1-7, Robeco Sustainability Report 2019).

Task Force for Climate-related financial Disclosures (2017). *Annex: Implementing the Recommendations of the TCFD* (pp. 1–82).

Task Force for Climate-related financial Disclosures (2019). Task Force on Climate-related Financial Disclosures: Status Report (pp. 1–144).

Turner, H. C., Lauer, J. A., Tran, B. X., Teerawattananon, Y., & Jit, M. (2019). Adjusting for Inflation and Currency Changes Within Health Economic Studies. *Value in Health*, 22(9), 1026-1032. doi: 10.1016/j.jval.2019.03.021

Warmerdam, W., J. de Wilde, J. W. van Gelder and A. Christopoulou (July, 2019). ABP's carbon footprint: Trend analysis per asset class and sector. Amsterdam, The Netherlands: Profundo.

7. Appendix

7.1 Bonds versus equities

The following section decomposes the WACI and the applied adjustment by asset class – equity and corporate bonds. In the main text, this study has shown that the adjustments influence insurers and pensions funds differently due to the differences in their aggregated portfolio compositions, by currency. This section illustrates the impact of the adjustment by asset class for each sector. By similar reasoning as in the main analysis, the impact of the proposed correction depends on the distribution of currencies in each asset class portfolio.

For the sample used to conduct the analysis, both sectors predominantly use EUR to invest in corporate bonds. By sector average, pension funds use EUR for 64.4%, and USD for 34.6%, of the monetary value of the corporate bonds they invest in 2019Q4. Insurers' corporate bonds are denoted for 93.4% in EUR, 6.4% in USD in 2019Q4. The green lines in figures A.1 and A.2 below depict the expected outcome given the corporate bond portfolio compositions described above. Since EUR dominates the corporate bond portfolios, the applied adjustment primarily reflects the inflation correction imposed on investments denoted in EUR. This can be seen in both graphs by the fact that the adjusted WACI line is always above the unadjusted WACI. Furthermore, the distance between the adjusted and non-adjusted WACIs becomes larger over time, which is explained by the fact that one has to control for more inflation over time.

Pension funds and insurers differ in their equity portfolio compositions. In 2019Q4, pension funds used, on average, USD for 46.3% and EUR for 17.7% of their equity investments. Similarly on average, insurers used USD for 29.2% and EUR for 47.2% of their equity investments. Since USD is more prevalent proportionately to the EUR for both sectors in the equity portfolios, relative to the corporate bond portfolios, the USD-EUR exchange rate fluctuations are more visible. In the figures below, the exchange rate fluctuations can be observed in several points. First, over the period 2012-2013 the USD depreciated relative to the EUR, which is reflected by the fact that the adjusted WACI is below the unadjusted WACI in 2013. Second, between 2013-2016 the USD appreciated relative to the EUR, which in turn is reflected in the graphs by the fact that the adjusted WACI diverges from the unadjusted WACI – the distance between the two WACIs increases over time. From 2016 to 2017, the USD depreciated to the EUR, and results in the adjusted WACI to come closer to the unadjusted WACI. Finally, from 2017-2019 the USD appreciated relative to the EUR which is reflected by the fact that the adjusted WACI diverts from the unadjusted WACI over the aforementioned time period. Since USD is more dominant in pension fund portfolios relative to the insurers' portfolios, these affects are more prevalent for pension funds and therefore also more visible in figure A.2.

Figure A.1: Insurer's adjusted and non-adjusted WACIs, by asset class

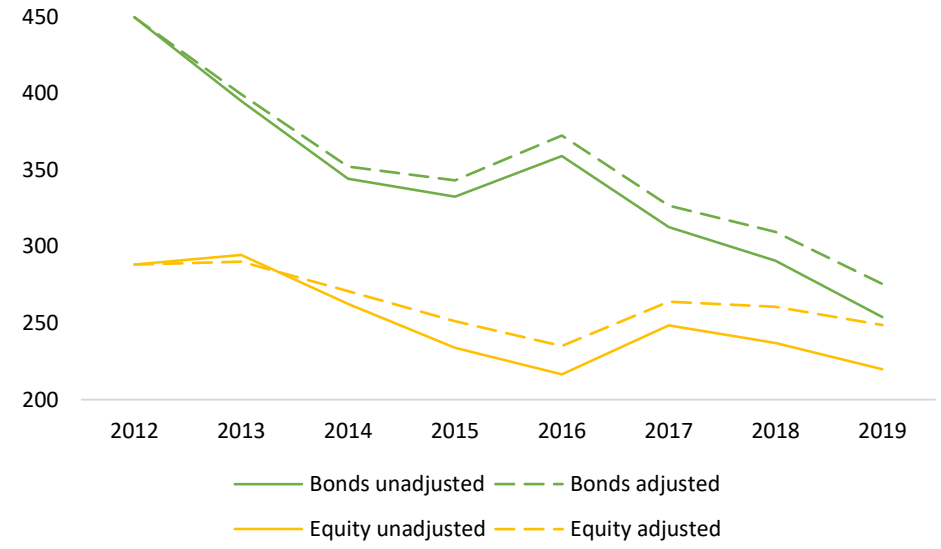
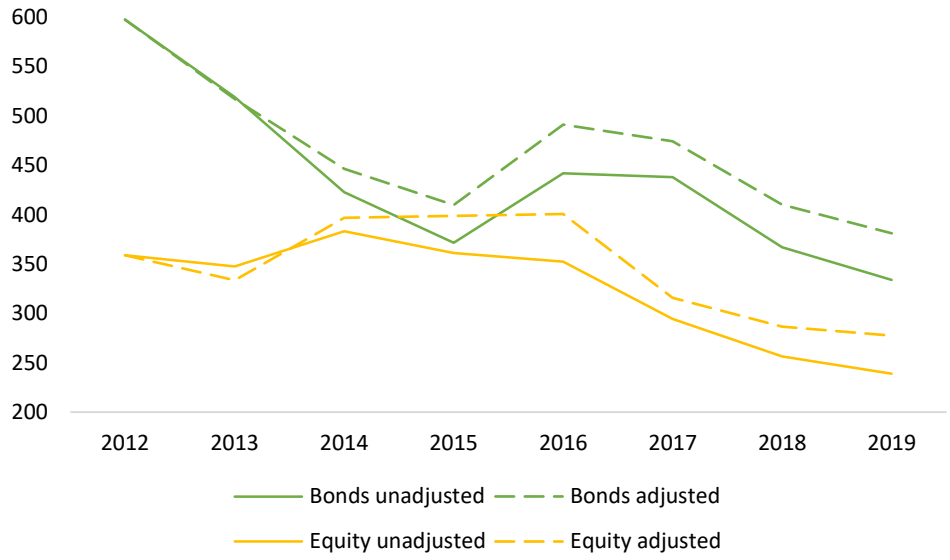


Figure A.2: Pension fund's adjusted and non-adjusted WACIs, by asset class



7.2 First investigation into drivers of "greening" of the portfolios

The following section compares the adjusted and non-adjusted WACIs for pension funds and insurers presented in section 4.2 to a benchmark. The benchmark is created by keeping the pension funds' and insurers' portfolios constant in 2012, and only letting the issuing companies' emissions and revenue variables vary over time. This benchmark is a hypothetical; what if the investors remain passive and do not change the composition of their portfolios over time. See figures A.3 and A4.

The conclusions of this analysis are twofold. First, pension funds and insurers have been actively improving their respective WACI. Having said that however, this does not necessarily imply that the *absolute* emissions of their respective portfolios have decreased over the same time period – improvements in the WACI can occur even if emissions increase or stay constant over time, while revenue increases by a proportionately larger amount. Second, this analysis shows that our proposed adjustment is robust and also has an impact when portfolios are frozen – i.e. the differences between the adjusted and unadjusted metrics do not stem from equity or corporate bond value changes, nor are they a by-product of specific investment choices made over time.

Figure A.3: Pension funds' adjusted and non-adjusted WACIs vs constant 2012 portfolio

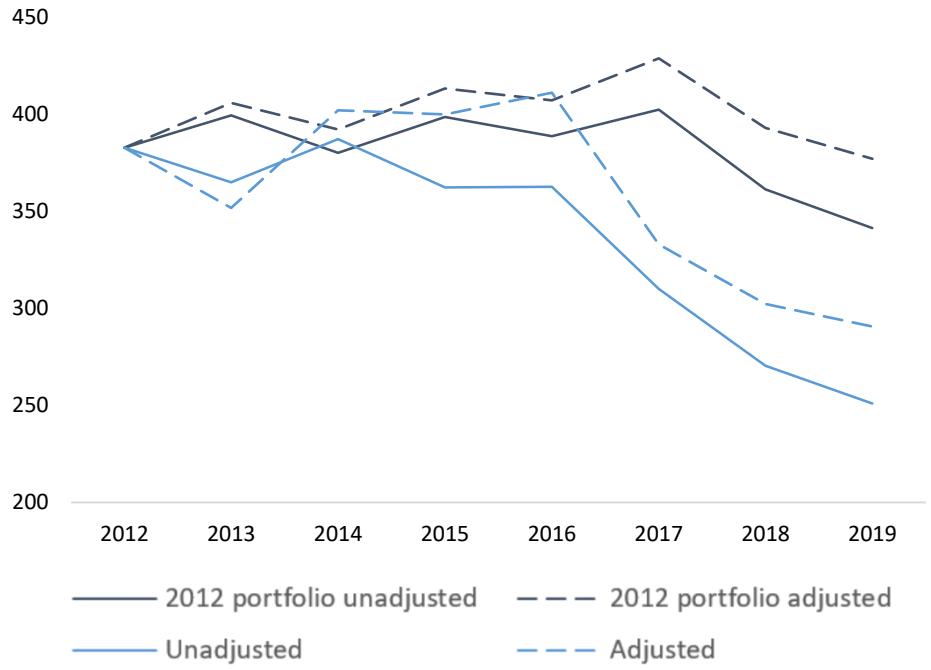
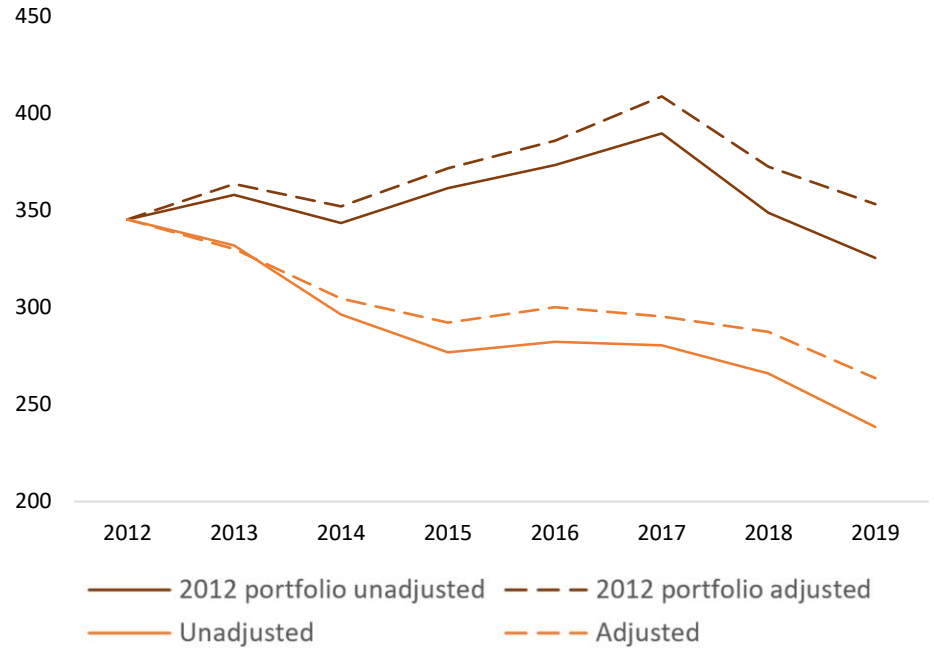


Figure A.4: Insurers' adjusted and non-adjusted WACIs vs constant 2012 portfolio



DeNederlandscheBank

EUROSYSTEEM

De Nederlandsche Bank N.V.
PO Box 98, 1000 AB Amsterdam
+31 20 524 91 11
dnb.nl