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Expanding carbon indicator scope by looking through investment funds – an overview of statistical methodologies[1]

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Expanding carbon indicator scope by looking through investment funds

An overview of statistical methodologies

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Abstract

With the increasing availability of security-by-security level data it is possible to look through investments in mutual funds and analyse indirect holdings, which gives more complete statistical outcomes compared to traditional direct approaches. However, there is a wide range of methods available in different countries depending on data availability and reporting limits. In this statistical note, we provide an overview of the different methodologies that can potentially be replicated in other countries. We showcase several look-through approaches to obtain carbon indicators of Dutch pension funds.

Keywords: look-through, mutual funds, securities holdings statistics, carbon.

JEL classification: C10, F21, G11, G23, Q54, Q56.

[1] All authors work at De Nederlandsche Bank. Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank or the Eurosystem.

1. Introduction

Statistical reporting is getting increasingly granular in nature. For portfolio investments line-by-line reporting of securities held and issued is becoming common practice worldwide. While these data allow for much flexibility, still many official statistics do not utilize the potential of such data fully. In particular, equity flows in investment funds (F.52) are often recorded based on the issuer characteristics instead of highlighting how investors in those funds have certain exposures related to the fund holdings.

In this study, we highlight how data on *direct portfolio* positions in investment funds can feed in more detail in aggregate statistical publications by looking through the investment fund holdings. From an investor perspective, these *indirect portfolio* investments via funds are important, but not always in the picture due to data gaps and reporting limits. In this paper we look through the fund holdings. Excluding indirect holdings may lead to misjudgement of risks, for example in relation to country exposure or carbon emissions. To illustrate a range of different look-through methods for indirect holdings (via investment funds), we present early findings of look-through carbon indicators, noting that the methods we set out here are much more versatile.[2]

In this note, we explain how to obtain a look-through for portfolio investment with four different approaches. First, we outline the "classic" look-through based on statistical reporting. Next, we explain how look-through via supervisory reports (if available) can be applied. Third, we propose a "synthetic" look-through based on commercial data. For these three different approaches we distinguish between domestic and foreign investment fund holdings, because of differences in data quality and data availability between domestic and foreign fund data. Therefore, we also highlight what we call a "hybrid" look-through approach (the fourth approach). This approach effectively uses a combination of available granular domestic fund reported data and foreign fund holdings information from either supervisory data or commercial sources.

We apply the different look-through methods to the calculation of carbon indicators for direct and indirect stock holdings. For investors, measuring carbon exposures correctly is important because their portfolio allocations carry climate transition risk that needs to be managed (see NGFS, 2024). Bolton and Kacperczyk (2021) show that for the US absolute financed carbon emissions through portfolio investment exposures (*Financed Emissions*) "represent a material risk for investors that is reflected in the cross-section of stock returns and portfolio holdings" (ibid, p.517-518). However, so far, indirect portfolio holdings have often been overlooked when

[2] Statistics on country exposures on portfolio investments suffer from a bias towards equities in countries with large investment fund industries such as Ireland and Luxembourg. The *direct* portfolio positions in investment funds are recorded in these offshore locations, but with a look-through they are no longer recorded against the country of the fund, but exploit the actual but *indirect* exposures of funds to different countries (see Vivar et al., 2020, Beck et al., 2024). Consequently, look-through approaches demonstrate lower home bias in the euro area (Boermans et al., 2022, Carvalho, 2022).

measuring carbon exposures of investors.[3] Here we aim to also capture the indirect exposures *through* fund holdings of investor portfolios in addition to their direct and self-managed portfolio holdings of listed shares. These indirect fund holdings are split into domestic fund holdings and foreign fund holdings to allow for a hybrid look-through approach combining the benefits of different methods.

Indirect holdings in investment funds are increasingly important, given the rise of the asset management industry. By looking-through indirect investments, investors become more aware of their *actual* exposures, for example related to climate risk. As asset owners, the investors in funds carry the full risks associated with the investment fund's holdings and can be viewed as responsible for those assets, while fund managers act on behalf of their clients, do not bear the risks associated with the assets and are not directly responsible. Hence, a more granular look-through approach allows for a better picture on the investors' exposures, whether this concerns climate risk associated with carbon or other measures of interest.

2. An overview of look-through methodologies

Investment portfolios can include a range of different financial instruments, where some of the portfolio is held *directly* in the issuing party (e.g. stocks, bonds) while other investments may be managed by investment funds as secondary parties. These investments *through* funds we describe as *indirect* investments. Since investment portfolios are used to assess the investor's exposure to several types of risk, accurate information on the issuers underlying the portfolio investments is indispensable for obtaining a complete picture of the investor's exposures, which combines the direct and indirect holdings.

The general working principle of the look-through methodology relies on regarding the investment fund as a transparent layer covering underlying assets, and "looking through" it to observe the assets directly. In this paper we distinguish four different approaches, and an additional hybrid combination of these, to obtain an investment portfolio that includes indirect investments (see Section 5.1. for a discussion with an appraisal of the main methodological challenges).

2.1 "Classic" look-through based on statistical reporting

Many countries have access to granular investment information via the reporting of their (domestic) financial institutions to their national statistical agency or central bank.[4] This reporting may also cover domestic *investment funds*. If so, the reported set allows for the implementation of the "classic" look-through methodology to

[3] There are two studies in the carbon exposure literature that apply a look-through approach using Dutch data from investment funds indirect exposures, see Boermans & Galema (2019) and Berkhout et al. (2023).

[4] In the European System of Central Banks (ESCB), much of the data reporting is aligned with the ECB Securities Holdings Statistics (SHS) Regulation, which sets out requirements for various financial institutions to report line-by-line securities holdings information, including investment funds.

calculate indirect investments via *domestic* investment funds. Typically, data is only available for domestic funds because statistical reporting requirements are often national and do not stretch beyond country borders.

Essentially, to calculate the indirect portfolio positions of an investor, one needs to join the participation in an investment fund with the underlying investments of the investment fund, in proportion to the ownership share of the investor in the fund (Berkhout et al., 2024). For example, the investor in Figure 1 invests €60 in fund 1, amounting to 10% of fund 1's market cap (€600). Applying the classic look-through, the investor gets attributed 10% of the investment portfolio of fund 1. In this way, the indirect holdings in BP, Chevron and Shell become part of the investor's total portfolio.

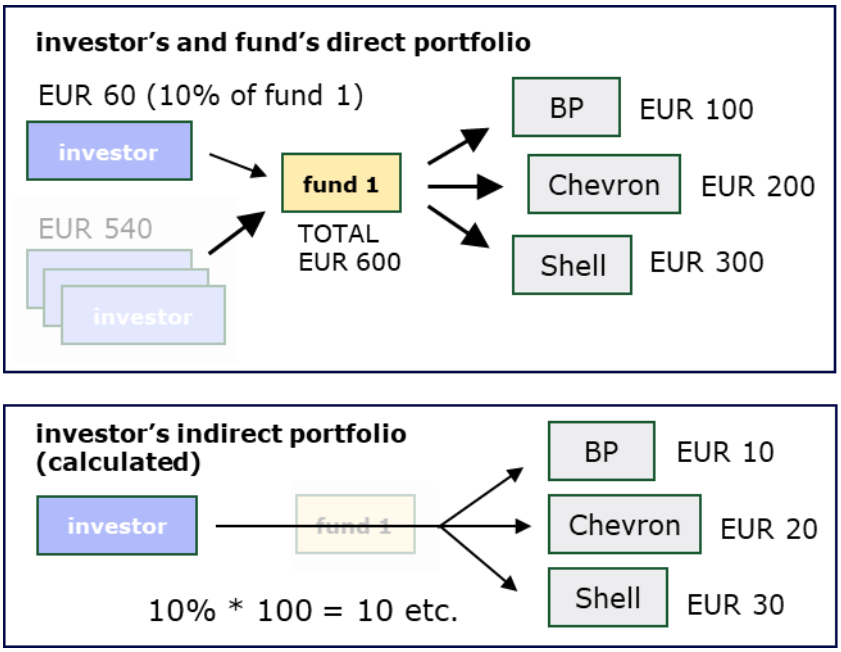

Figure 1: "Classic" look-through approach: an investor's indirect portfolio positions (held *via* investment funds) are calculated by taking the investment fund's portfolio and multiplying it with the investor's investment share (weight) in this fund.

Note that part of the investment funds' investments is in other investment funds. Including such fund-of-fund structures in the look-through requires a second (or multiple) order implementation of the methodology, which is in principle straightforward but not covered in this note.

2.2 Look-through via supervisory reports

Another pathway to obtain an investor's indirect investments is to request their indirect portfolio from the investment fund directly. Here statistical agencies or central banks request look-through reports from investors (or supervisory authorities) such as pension funds and insurance companies. In Europe, the European Insurance

and Occupational Pensions Authority (EIOPA) is a European Union financial regulatory agency which applies look-through reporting for various supervisory purposes. Specifically, the investor not only reports on the direct holdings, including those in investment funds, but in addition must report on the investments it carries *through* the holdings in the investment fund. These reports may contain ready-to-use indirect holdings (Figure 2).

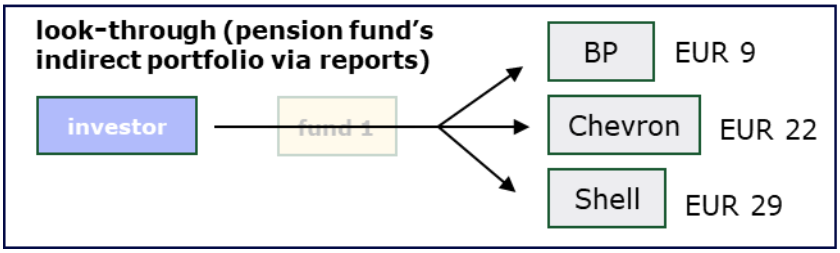

Figure 2: Look-through via supervisory reports. As opposed to the classic look-through approach, supervisory reports readily contain indirect portfolio holdings of the investor, where the investor provides detailed information on the holdings of the investment fund.

In the Netherlands, investment funds report their portfolio to pension funds, which in turn report these looked-through holdings to the supervisory authority directly. For Dutch pension funds, this look-through data has a similar granularity and level of detail[5] as the classic approach. This allows us to calculate carbon indicators using look-through data based on the classic approach as well as on the supervisory approach. In theory, these two calculations should yield similar outcomes. However, while for the classic approach the investment fund population is restricted to domestic funds, supervisory data typically does include investments via foreign investment funds. Depending on the importance of foreign fund investments, carbon indicator outcomes may not be comparable.

2.3 Synthetic approach

Ideally, detailed data on investment funds' portfolio holdings worldwide are available to calculate indirect exposures via funds. However, such data is often absent, especially for foreign funds. The classic approach is often confined to domestic funds. The supervisory reports for global funds are not always available nor complete for all fund positions. In addition, data to implement both approach 1 and 2 may not be available. Hence, to estimate the complete indirect positions we outline a synthetic portfolio holdings approach using commercial data.

Synthetic portfolio holdings are obtained by characterising each investment fund globally, and attributing a detailed fund portfolio synthetically, based on the fund characteristics (see e.g. Boermans et al., 2022). In practice, typically fund type

[5] FTK reporting templates K209: Aanwijzingen bij de FTK Verslagstaten taxo 3.0.0 (dnb.nl)

information is available from commercial data providers. Using fund type information, a synthetic portfolio for each fund (both for domestic and foreign) held by an investor, can be created. This allows one to obtain a complete approximation of the indirect portfolio investments.

An equity fund that has a certain investment area or industry as focus can be ascribed to hold a representative portfolio of each asset with that characterization. For example, a global energy fund is assumed to hold all global energy stocks, where the portfolio weights for each stock *i* are determined by the market portfolio weights of that benchmark. If BP represents 10% of the global energy listed stocks, then investor *j*'s indirect holdings through fund *f* in BP will be based on weight 0.1 (Figure 3). Similar logic can be applied to any fund.

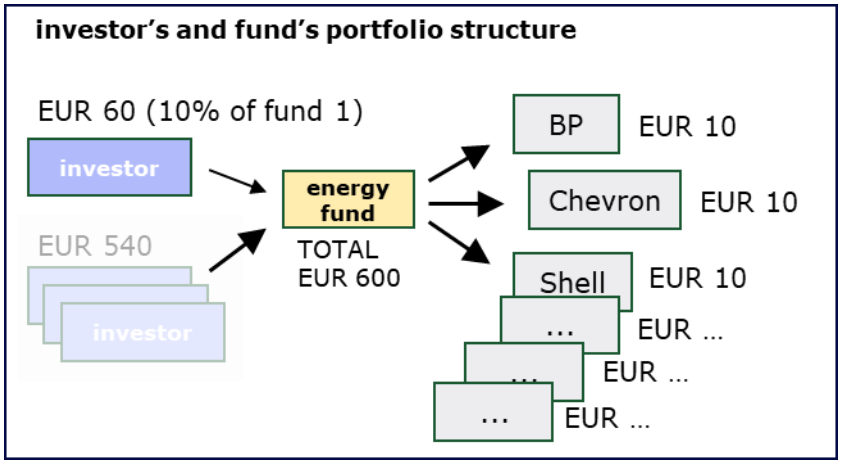

Figure 3: Synthetic look-through approach. Fund holdings are derived based on fund characteristics and used to assign an indirect investment portfolio to the investor, using market capitalisation as weight.

There are several ways in which (foreign) investment fund positions can be calculated. Apart from using market capitalization and fund characteristics to create a synthetic portfolio, one can use up to date constituency lists with actual portfolio holdings for all the funds *f* held by investor *j* at time *t*. This type of data is becoming more readily available, with investment funds becoming more transparent about their holdings. In theory, the constituency list provides an overview of the investment fund holdings. When domestic funds report their holdings, these data should be similar.[6] Several data providers such as Morningstar and LSEG Lipper allow for the downloading of complete lists of holdings. For this approach, one combines the reported direct holdings of the investor in specific funds with the information on the fund constituencies from commercial sources.[7]

[6] Note therefore that this data can also be used for verification of approach 1 and 2.

[7] Within the European System of Central Banks (ESCB), the Securities Holdings Statistics – Sectoral (SHS-S) offers the granular holdings of investment funds for money market instruments, bonds, and listed stocks. Here one may assume that a holding in a foreign fund located in any of the participating countries is representative in aggregate for the investor's indirect positions held through these investment funds (see Vivar et al., 2023).

2.4 Hybrid look-through approach

Depending on data availability, the three approaches can also be combined. For example, one may use the domestic fund holdings data reported in the statistical framework under approach 1 and combine that with the (mainlyt foreign) fund holdings data either from supervisory reports (approach 2) or/and using a synthetic portfolio construction (approach 3) (see Figure 4). Other combinations are possible, for example when the coverage for the domestic funds is incomplete, one may use the synthetic approach for the remaining domestic funds to get complete coverage of the entire *indirect* portfolio of the investor, incorporating all available investor, fund, and firm level data.

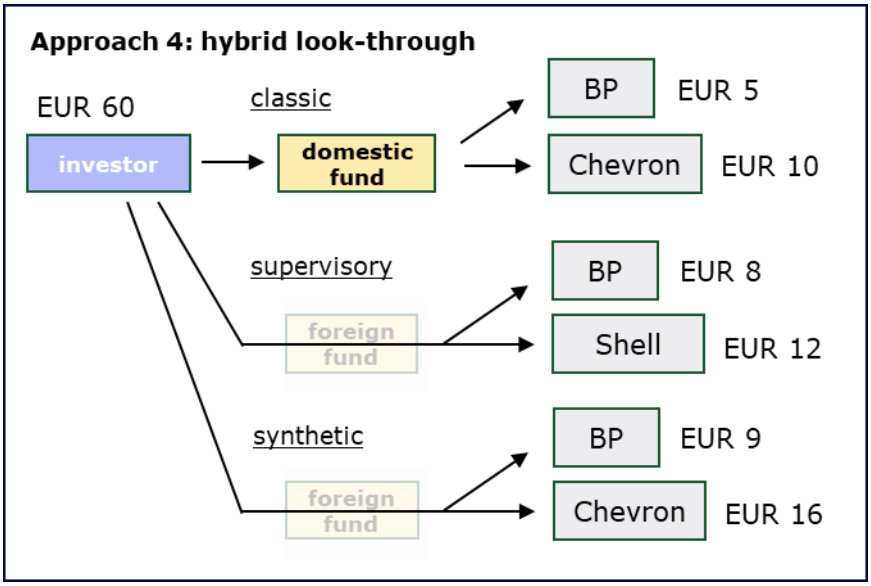

Figure 4: The hybrid look-through approach can be a combination of the classic, supervisory, and synthetic approach. The example combination in this figure combines the classic approach for domestic funds with supervisory and synthetic indirect holdings for positions in foreign funds.

3. Methodology for look-through and carbon indicators

In this part we set out formulas to apply the look-through method and provide the formulas for calculating carbon indicators for total portfolios with both direct and indirect holdings of investors included in the statistical aggregates.

3.1 Weights for direct and indirect holdings

When granular security information at the instrument level is available for both i) financial institutions' investments in domestic investment funds, and ii) domestic investment funds' portfolio holdings, the indirect holdings of financial institutions

can be calculated using a look-through methodology in a straight-forward manner (see also Boermans et al. 2022, Carvalho, 2022, Berkhout et al. 2024).

Each investor's portfolio can be divided into two components. Investment under direct management and those held indirectly through investment fund holdings in fund *f*. Hence the total portfolio holdings *H* of an investor j in different assets i (including securities issued by company i) at time t can be represented as the following sum of direct and indirect investments:

$$(1)\quad H_{j,i,t}^{\text{total}} = H_{j,i,t}^{\text{direct}} + H_{j,i,t}^{\text{indirect}}.$$

Let the market value of the portfolio holding H of investor j in investment fund f at time t be written as $H_{j,f,t}$, while the total market capitalization of the investment fund I by fund f at time t is denoted $I_{f,t}$, which includes both domestic and foreign issuances. Then, each investor's ownership share $p_{j,f,t}$ can be calculated as

$$(2)\quad p_{j,f,t} = \frac{H_{j,f,t}}{I_{f,t}}.$$

All issued shares of investment funds appear on the liabilities side of the balance sheet of the investment fund, while the fund's securities holdings appear on the assets side of the balance sheet. Let the securities holdings H that fund f invests in i at time t be given by $S_{f,i,t}$ where i denotes the issuing company.

Now, to obtain a more accurate asset allocation of a financial company's holdings via investment fund participation, for each combination of holder j and investment fund f at time t, the ownership share is multiplied by the holdings of the fund:

$$(3)\quad H_{j,i,f,t} = p_{j,f,t}\, S_{f,i,t}.$$

$H_{j,i,f,t}$ thus denotes the investor's j's portfolio holdings of securities issued by company i, held *indirectly* through investments placed in fund f at time t. Finally, we sum over investment funds f to obtain the indirect investment portfolio $H_{j,i,t}^{\text{indirect}}$ which can be appended to the financial company's own investments $H_{j,i,t}^{\text{direct}}$:

$$(4)\quad H_{j,i,t}^{\text{indirect}} = \sum_f H_{j,i,f,t}.$$

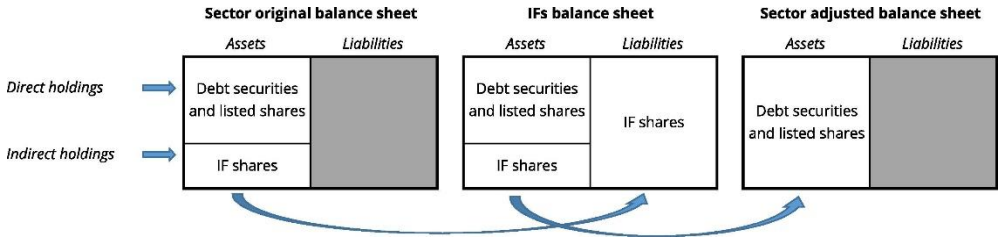

Figure 5: Illustration of look-through with balance sheet data
Adapted from Carvalho (2022).

To summarize, for the classic approach the indirect holdings are obtained with a merge as illustrated in Figure 5, where the assets of the fund are linked through the holdings of "IF shares". By contrast, in the supervisory approach, those assets are directly reported. In the synthetic approach the information on the assets of the investment funds is estimated with synthetic portfolio construction based on fund categories that are matched with asset characteristics.

3.2 Calculating carbon indicators

In this section, we outline the calculations of two commonly used carbon indicators, specifically the Financed Emissions and Weighted Average Carbon Intensity (WACI) of investors (ECB, 2024a; NGFS, 2024), which we then derive with different look-through approaches applied to the Dutch pension sector. Note that there are also other carbon indicators related to investor's exposures, such as those provided as part of the set of ESCB Climate-change related indicators (see ECB, 2024a and ECB, 2024b).

We will analyse both scope 1 (direct emissions) and scope 2 (indirect emissions from energy inputs) carbon emissions as this is currently the most common practice, as data on scope 3 is often incomplete.

3.2.1 Financed Emissions (FE)

Let investor j's holdings of securities issued by company i at time t be denoted $H_{j,i,t}$ (indirect holdings via investment funds can simply be added to this portfolio following the methodology outlined above). Then with $V_{i,t}$ the company value in terms of enterprise value including cash, EVIC, and $E_{i,t}$ the carbon emissions of issuer i, the Financed Emissions (FE) of investor j's holdings of issuer i at time t is given by

$$\text{(5)}\quad \mathrm{FE}_{j,i,t} = \frac{H_{j,i,t}}{V_{i,t}} E_{i,t}.$$

Due to the absolute nature of the indicator, the total Financed Emissions at portfolio level are calculated by summing over all issuers

$$\text{(6)}\quad \mathrm{FE}_{j,t} = \sum_i \left(\frac{H_{i,j,t}}{V_{i,t}} E_{i,t}\right) \mathrm{FE}_{j,t} = \sum_i \left(\frac{H_{i,j,t}}{V_{i,t}} E_{i,t}\right).$$

Note that investor j can denote a single financial institution, just as well as a financial sector or a country. Since FE is an absolute carbon indicator, the FE for a portfolio that includes both direct and indirect investments can in principle be broken down into FE through direct investments and FE through indirect investments.

3.2.2 Weighted Average Carbon Intensity (WACI)

The Weighted Average Carbon Intensity[8] is a relative measure that measures greenhouse gas emission per million euros of revenue weighted according to the investor's portfolio weight.

The carbon intensity of company i is defined by the ratio:

$$(7)\quad \mathrm{CI}_{i,t} = \frac{E_{i,t}}{R_{i,t}}$$

where $R_{i,t}$ is company i's revenue at time t. Subsequently, to arrive at the weighted sum of carbon intensities for an investment portfolio, $\mathrm{CI}_{i,t}$ is weighted by the value of the investment in company i relative to the investor's entire investment portfolio. This weight w of company i in investor j's portfolio is given by:

$$(8)\quad w_{j,i,t} = \frac{H_{j,i,t}}{\sum_i H_{j,i,t}}.$$

The WACI for an individual investor, financial sector or country j at time t is then calculated by summing the weighted carbon intensities over all issuers in the portfolio.

$$(9)\quad \mathrm{WACI}_{j,t} = \sum_i w_{j,i,t}\mathrm{CI}_{i,t}.$$

Note that due to its relative nature, the WACI of a portfolio that includes both direct and indirect investments must be calculated including all investments at once and cannot be broken down into a sum of direct and indirect WACIs.

4. Data and early findings

In this section we illustrate different look-through approaches based on statistical (classic approach 1) and supervisory data (approach 2) from Dutch pension funds' direct and indirect listed stock investments (F.511) in non-financial companies (S.11) in 2021. For the synthetic approach 3 we obtain global portfolio holdings of investment funds from Lipper.[9]

[8] The concept of taking the weighted average of the issuers' carbon intensity in a portfolio, to obtain a relative carbon measure, carries different names across literature. Sometimes it is referred to as the "Carbon Footprint" (Anderson et al. (2016), Boermans & Galema (2019), Aswani et al. (2024)), while in ECB publications on climate related indicators it is referred to as the "Weighted Average Carbon Intensity" (ECB, 2024a).

[9] We apply the fund categories based on investment area, industry, market capitalization and dividend (see Boermans et al., 2022). The ESCB Centralised Securities Database (CSDB) is used to get this information at the stock level.

4.1 Data on pension funds' investments

Within our data scope, Dutch pension funds hold around €185 billion in direct stock positions and €250 billion in stocks through investment funds, hence more than half of the total portfolio consists of indirect holdings.

To calculate carbon indicators, we merge the pension funds' direct and indirect portfolios to carbon emission data from Institutional Shareholder Services (ISS), complemented with imputed carbon data from the ECB's Expert Group on Climate Change Statistics (ECB, 2024a). For non-financial stock holdings, this results in a coverage (depending on the approach taken) of more than 90% for direct and indirect holdings.

4.2 Early findings

Disclaimer: the numbers presented in Figures 6 and 7 below are of an exploratory nature for illustrative purposes and are only indicative of any final figures, hence they do not provide any official statistics to be quoted for future reference.

To illustrate a practical application of the methods, Figure 6 and 7 show the carbon indicators of the Dutch pension fund sector's investments in listed shares issued by non-financial companies (in 2021). Of the four look-through approaches[10], approach 1 and 2 show final data, and the synthetic approach 3 is based on placeholder (fictional) data, giving estimates for approach 4 which combines 1 and 3 in a hybrid method. Note that classic approach 1 currently excludes foreign investment funds due to data coverage, while the supervisory and synthetic approaches 2 and 3 can include them based on different data sources.

Figure 6 shows Financed Emissions for both scope 1 (direct emissions) and scope 2 (indirect emissions from energy inputs), measured in million tonnes of CO_2 equivalents. The total portfolio size of direct and indirect investment is around €435 billion. Clearly, independent of the approach taken, the indirect investments make up the majority of the Financed Emissions as a significant part of the total portfolio (57%) is allocated towards investment funds.

[10] In our example, approach 4 is a hybrid of the classic approach (1) for domestic funds and the synthetic approach (3) for foreign funds, although other combinations are also feasible. Our Early Findings in this section focus on this because the data gap in the classic approach is the largest, as all foreign fund holdings (and those in small domestic funds) are missing.

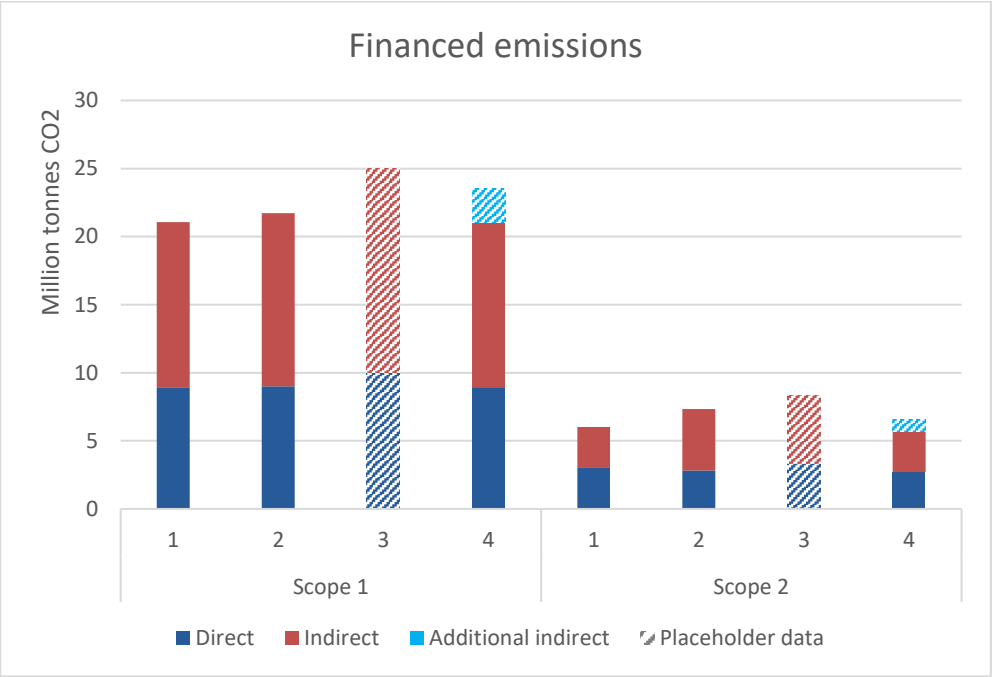

Figure 6[11]: Financed Emissions based on different look-through approaches (1 = classic statistical, 2 = supervisory, 3 = synthetic, 4 = hybrid (1+3)).

When comparing Financed Emissions between approaches it is important to reach full coverage or use grossing up (see Section 5.2). Due to increased coverage, the synthetic approach (3) will lead to higher Financed Emissions. However, this also depends on the deviation of the actual fund holdings compared to the estimated ones from the synthetic portfolio construction. In approach (4) we observe "Additional indirect" holdings based on synthetic portfolio data to complement the holdings not observed in approach 1.

Figure 7 shows the Weighted Average Carbon Intensity for each of the four look-through approaches. Compared to the Financed Emissions (Figure 6), the aggregate statistical indicators across the different parts of the portfolio (direct and indirect) for approach 1 are more comparable for the Weighted Average Carbon Intensity (Figure 7). This is largely due to the fact that the WACI is a relative indicator, implying that differences in portfolio size are less relevant than for an absolute indicator such as Financed Emissions. Note that for Dutch pension funds, the total Weighted Average Carbon Intensity declines when indirect holdings are included, while "by construction" of expanded coverage, Financed Emissions increase (see for similar results, DNB, 2024).

[11] *Disclaimer: the numbers presented in this Figure are of an exploratory nature for illustrative purposes and are only indicative of any final figures, hence they do not provide any official statistics to be quoted for future reference.*

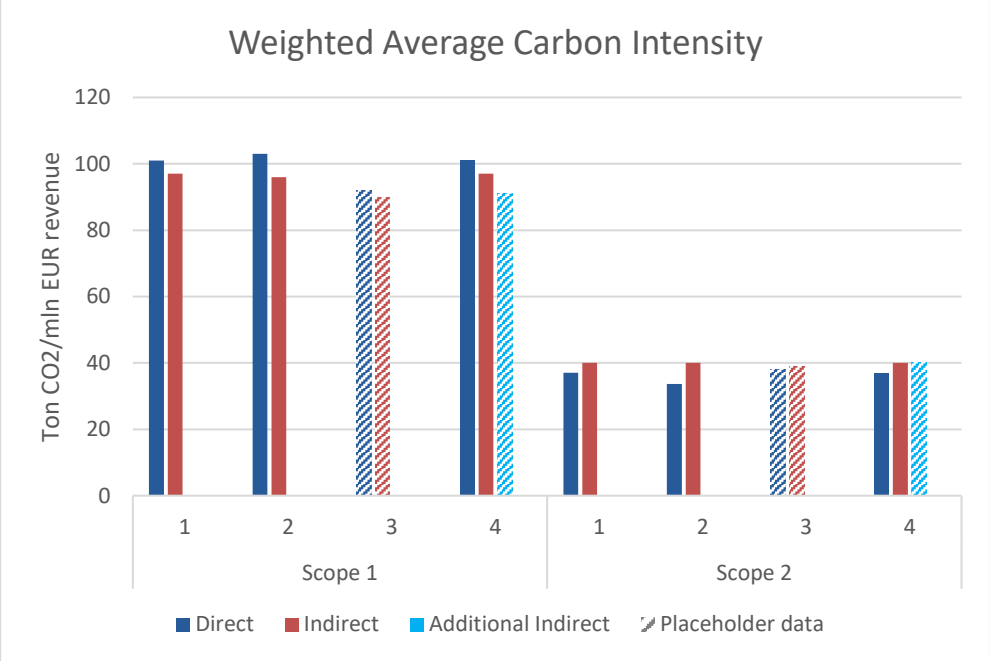

Figure 7[12]: Weighted Average Carbon Intensity (WACI) based on different look-through approaches (1 = classic statistical, 2 = supervisory, 3 = synthetic, 4 = hybrid (1+3)).

[12] *Disclaimer: the numbers presented in this Figure are of an exploratory nature for illustrative purposes and are only indicative of any final figures, hence they do not provide any official statistics to be quoted for future reference.*

5. Discussion

5.1 Methodological appraisal and comparison

The four approaches are briefly summarized in Table 1, outlining the main benefits and challenges.

Approach	Main benefits	Main challenges
(1) **Classic**: indirect investments are calculated by coupling granular investment fund data to the investor's participation in this fund.	1) Data quality and coverage are high. 2) Based on data that the Central Bank receives directly from financial institutions (no intermediaries).	1) Only applicable to domestic investment funds, as foreign funds' investment data is often not available. 2) Data availability and legal reach for reporting requirements vary across jurisdictions.
(2) **Supervisory**: indirect investments are reported (by investment funds) to their investors, that in turn report to the supervisory authority.	1) Reports contain ready to use holdings, no calculations needed. 2) Includes indirect investments via foreign funds.	1) Reporting duties for funds vary across investors, resulting in inconsistencies in fund data, in comparison to approach 1. 2) Data availability and legal reach for reporting requirements vary across jurisdictions. 3) Higher reporting burden.
(3) **Synthetic**: investment funds are characterised by certain commercially obtained properties (e.g. energy fund). Investment fund portfolios are estimated based on these properties (e.g. on all energy stocks).	1) No prior fund holdings data needed. 2) Applicable to domestic and foreign investment funds.	1) Investment fund portfolios are an approximation. 2) Sensitive to classification of the fund categories.
(4) **Hybrid**, a combination of the approaches 1, 2 and 3 (e.g. add foreign data from approach 2 or 3 to approach 1).	1) One approach can be used to complement another approach.	1) Results in variation in data coverage and quality within the total indirect portfolio. 2) More difficult international comparison.

Table 1: Overview of approaches discussed in this paper.

5.2 Methodological challenges

The existence of different approaches to obtain indirect holdings of investors leads to several methodological challenges, especially when making statistics comparable across countries.

5.2.1 Data coverage and quality

To implement the look-through methodologies proposed in this paper, data quality and coverage are key to the result. This is especially true when calculating carbon indicators. The impact of data quality and coverage runs through several channels. First, the availability of carbon data[13] shapes the investment universe under study, hence restricting the total portfolio of both direct and indirect holdings in terms of coverage. Data quality and coverage of emission data also varies considerably across data providers.[14] While data on market caps and revenues of firms and fund values are widely available, the sample is mostly restricted by the firms for which the commercial data provider has the carbon emissions (in this paper we use carbon data from ISS). This can be problematic when certain firms with very low or very high carbon intensity are excluded from the sample. Fortunately, reporting of carbon data is improving in terms of coverage and quality (NGFS, 2024). Additionally, one can increase the carbon coverage with imputations of carbon emissions (ECB, 2024a).

Second, the data quality of fund holdings varies across approaches and between domestic and foreign funds. The classic approach (1) has the advantages of using directly reported data of funds themselves, yielding high quality data for the look-through. Still, part of the domestic investment funds' portfolio may not be available when small funds are exempt from reporting. The supervisory approach (2) relies on data from different investors on a single investment fund X, which can lead to inconsistencies in the portfolio holdings (constituencies) of that fund X. In addition, the investors may not be able to fully report on all their indirect holdings via funds, because a) not all funds report and b) not all reporting is complete. The synthetic approach (3) is sensitive to the classification of the fund categories (see Annex 1 for details).

As the total portfolio will not be fully covered (that is, part of the direct and indirect holdings may be missing), one may want to revert to a *grossing up methodology*. While grossing up will be imperfect, its advantage is that it ensures a full portfolio coverage, which is especially important for the Financed Emissions and comparability across countries and sectors. Typically there are two ways to implement grossing up. One may use a market weighted average benchmark which assumes that the unobserved holdings follow the market average (see DNB, 2018), to recalculate the

[13] For the calculation of carbon indicators in this paper, we follow the approach of the ECB Expert Group on Climate Change Statistics (ECB, 2024a). This includes the imputation of several missing carbon data.

[14] When statisticians use different sources, their estimated carbon footprints cannot be compared without considering these biases., see Klaaßen et al. (2021) on problems with Scope 3 data, and on Scope 1 vs Scope 2 and reported vs estimated values, see Busch et al. (2018), Bajic et al. (2023) and Swinkels and Markwat (2023) and IMF (2023) on divergences in carbon emissions in general.

carbon indicators (now including the unobserved part of the total portfolio). Alternatively, one may gross up using simple averages of the observed part of the holdings, hence assuming that the unobserved part will have a similar carbon exposure as the part observed of the investor.

5.2.2 Limited scope

Next to data quality and coverage issues, a second methodological challenge relates to the data in scope. First, for the illustration of the methodology presented in this paper we restrict the sample to listed equity (F.511). However, other assets of funds such as bonds and real estate may also be included. Second, for the calculation of carbon indicators we focus on exposures related to non-financial companies (S.11), in line with the recent publication of the ESCB Climate change-related indicators (ECB, 2024a). In practice, investors also have (indirect) investments in financial institutions and governments, whose carbon exposures are more difficult to determine. Third, in this paper we focus on the year 2021. When producing a time-series however, one must account for inflation effects. Janssen et al. (2021) show how for comparison between time periods, carbon intensities require adjustment for inflation which affects firm revenues. In high inflation environments, gross revenues rise and mechanically reduce the investor's carbon footprint. Finally, our methodology does not explicitly consider that investment funds may also have portfolio investments in other investment funds. In principle, one may apply funds-in-fund structures as well which requires a recursive calibration to obtain a full data in scope.

5.3 Methodological opportunities for improved statistics

The existence of different approaches to calculate indirect holdings of investors also has important statistical benefits to ensure data quality.

Validation exercises

Having the inputs to complete different approaches allows statisticians to cross-validate their calculations. When differences are large, these can be investigated on a line-by-line basis to improve reported data or apply changes to the synthetic portfolio fund categories. For example, one can calculate (using approach 1) indirect portfolios related to domestic funds and compare these reported *domestic* fund holdings with synthetic (approach 3) *domestic* portfolios.

Additionally, several approaches can be combined to increase portfolio coverage. For example, for the classic approach (1) the main coverage issues come from the fact that data on domestic funds is partially missing, and data on foreign funds is not available (see also Berkhout et al. 2024). One can add investment data of the funds (both foreign and direct) for which data is missing, via supervisory (2) or the synthetic (3) approach.

Metadata

Finally, it is important to be transparent about the approach taken and report on metadata underlying the statistics in the methodological documentation, especially when comparing statistics across countries (see e.g. ECB 2024b).

6. Concluding remarks

Including full portfolio exposures of both direct holdings and indirect holdings (via investment funds) is important for the statistical compilation of carbon indicators. We provide an overview of look-through approaches for the compilation of investors' Financed Emissions and Weighted Average Carbon Intensity associated with their portfolio investment. The look-through approach can be accomplished in multiple statistical ways: (i) with statistical reports from the investments funds, (ii) with supervisory data from the reporting investors directly or (iii) using synthetic portfolios of the investment funds, which is especially useful for foreign mutual fund holdings. Finally, these three approaches can be used in complementary ways leading to a (iv) hybrid look-through approach.

These four look-through methods can more widely be applied to other statistical publications such as "total" investor's country exposures to risk which include the underlying assets held through investment in funds. When applying look-through methodologies to construct and compare carbon indicators or comparing carbon exposures of different investors across countries, statisticians and policy makers must be aware of a range of methodological challenges. Therefore, having multiple approaches allows for more flexibility and cross-validation of outcomes.As investors may struggle to manage climate related risk of indirect portfolios, measuring full exposures is important.

The overview of approaches presented in this note can facilitate the inclusion of indirect holdings in statistical aggregates. Using carbon indicators as a case study, our work highlights how data on *direct portfolio* positions in investment funds can feed in more detail in aggregate statistical publications by looking through the investment fund holdings.

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Annex: Synthetic approach challenges when looking through funds

The synthetic approach has a few challenges. First, the data quality of the fund characterization as well as the asset *i* characteristics need to be adequate. That is, the type of fund needs to be sufficiently detailed to align with the type of underlying firms. However, a too detailed classification risks missing assets that the fund may in fact hold, while a too loose classification will lead to the inclusion of firms that the fund will not invest in. In addition, the qualification of assets, in our example listed stocks, must be well-aligned as well. For example, the classification of an Energy firm needs to be correct as well in the reference data.[15]

Second, because the actual fund portfolio weights are unknown, the use of the global market benchmark portfolio serves as a proxy (see e.g. Boermans et al., 2022 taking a CAPM approach). In practice, fund allocations will deviate from this benchmark, both in weighting across different assets *i* and in their selection of which assets to include and exclude. As a result, the synthetic portfolio constructed via this approach will contain assets that are not part of the portfolio or contain the "correct" assets but weighted differently.

Another data requirement for the synthetic approach is to have good reference data on the complete list of potential assets that are grouped by the possible categories. Commercial data providers offer lists of all listed stocks and their market values as well as asset categories (such as issuer country and firm industry). In the euro area, The Centralised Securities Database (CSDB) provides such rich source allowing one to obtain a full list of assets and their market value for the weights assigned to each underlying asset.

Another related way is to not use the individual fund information but to fall back on averaging over industries or countries, which may not be representative for the actual portfolio choices of the investor. For example, the ECB (2023) applies an aggregate look-through where it assumes that a Dutch investor with fund holdings in country A will mimic exactly the *average* country A's fund portfolio allocations towards certain countries and sectors. While this approach is a significant improvement, in practice, investor 1's indirect holdings in country A's fund target specific funds in that country A where overall allocations will deviate from the total fund holdings from country A.[16]

[15] The details of the fund characteristics will affect the quality of the match with the true underlying portfolio of the investment fund. On the one hand, having a lot of detail has the advantage to pick stocks more carefully, making it less likely that stocks are included that are unlikely to be part of the actual fund portfolio (Type 1 error). On the other hand, having strict characterizations of the funds is difficult in practice and will inflate the presupposed precision of the method. Narrow fund classes may suffer from more data quality issues that carry over in the selected stocks that will be represented for the fund. Hence, many stocks that are included by the fund in the actual portfolio may be missed (Type 2 error). Striking a balance depends on the topic under investigation, e.g. for carbon intensities the *industry classification* is very important, whereas for the calculation of country exposures of indirect holdings no details on industry is required.

[16] Moreover, a granular approach with synthetic data is sensitive to outliers. For instance, when investors choose to invest in certain firms with very high carbon intensity, an approach based on country level or industry level will never be able to capture different portfolio allocations towards such outliers, and hence give a biased estimate. However, constructing fund specific indirect holdings with the synthetic look-through approach is sensitive to such outliers, but to a much lesser extent as statistically speaking with a sufficiently large number of different investment funds in scope with indirect investment spread out.

Expanding carbon indicator scope by looking-through investment funds

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Statistics and beyond:
new data for decision making in central banks

Annemarie Berkhout
Martijn Boermans
Justin Dijk
Wim Goossens
Trond Husby

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Introduction

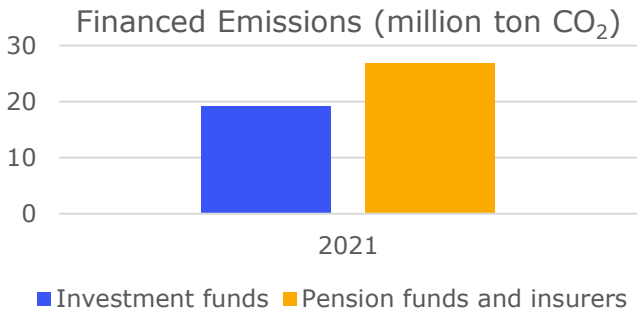
Problem statement

- Investment portfolios consist of **direct** portfolio investments and **indirect** holdings via investment funds
- Indirect holdings are **not always in the picture**, due to data gaps and reporting limits
- Only looking at direct holdings may lead to **misjudgement of risks**, for example in relation to country exposure or carbon emissions

Solution

- We present three **look-through approaches** to complement direct portfolios with indirect investments
- To illustrate, we expand **carbon indicators**' scope by looking-through investment funds

In the Netherlands, a significant part of Financed Emissions is attributed to investment funds



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Casus: carbon indicators

- The look-through approach is **versatile** and can be applied to any financial sector, country, and in any risk assessment context
- To illustrate look-through applied in a risk assessment context, we calculate carbon indicators for investment portfolios of **Dutch pension funds**

Carbon indicators

- We calculate **Financed Emissions** and **Carbon Footprint**, as recommended by the TCFD and the ECB expert group on climate change statistics

Financed Emissions	**Carbon Footprint**
absolute indicator (in mln tons CO_2)	relative indicator (in tons CO_2 / mln EUR)
$\sum \frac{\text{holdings}}{\text{company value}} \text{emissions}$	$\sum \frac{\text{holdings}}{\sum \text{holdings}} \frac{\text{emissions}}{\text{revenue}}$

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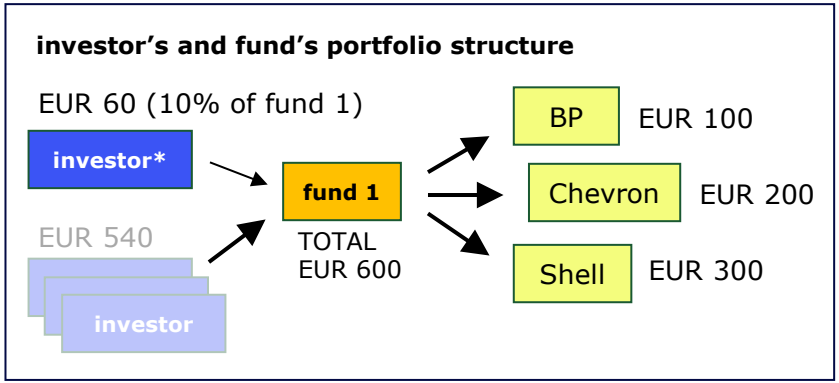
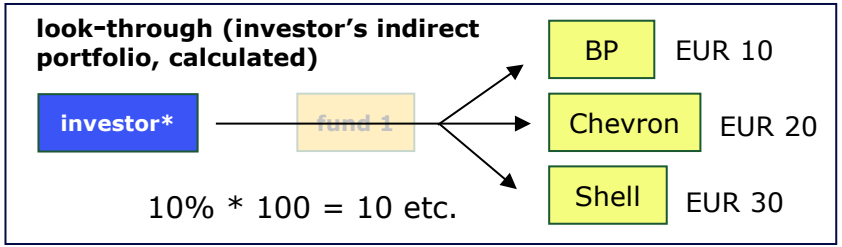
Three approaches

- Approach 1: “Classic” look-through based on statistical reporting
- Approach 2: Look-through via supervisory reports (if available)
- Approach 3: “Synthetic” look-through based on commercial data

Approach 1) “classic” look-through

- Allocate the **investment fund** holdings to the investor proportional to the investor’s ownership share of the fund





The investor is asset owner and carries full risk on BP, Chevron and Shell

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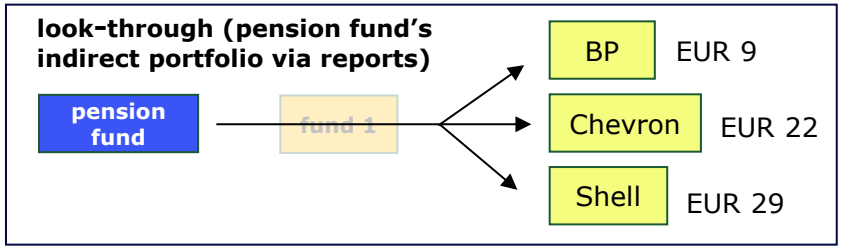
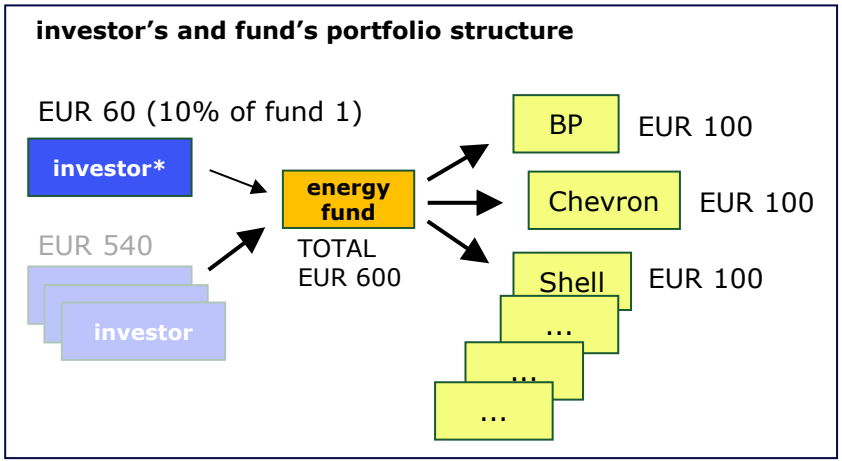
Approach 2) look-through via supervisory reports

- In the Netherlands, investment funds report their portfolio to pension funds, which in turn report these **looked-through holdings** to the supervisory authority directly
- These reports contain ready-to-use indirect holdings, meaning that **no calculations** are necessary



Approach 3) “synthetic” look-through based on commercial data

- Ideally, **detailed data** on investment funds’ portfolio holdings worldwide are available to calculate indirect exposures via funds
- However, such data is often absent, especially for **foreign funds**
- To estimate these positions we use **synthetic portfolio holdings**
- Synthetic portfolio holdings are obtained by **characterising each investment fund** globally, and attributing a detailed fund portfolio synthetically, based on the fund the characteristics



The energy fund’s positions are estimated, based on global energy stock’s market values

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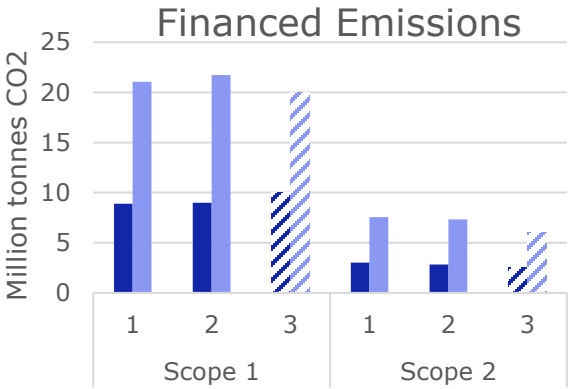
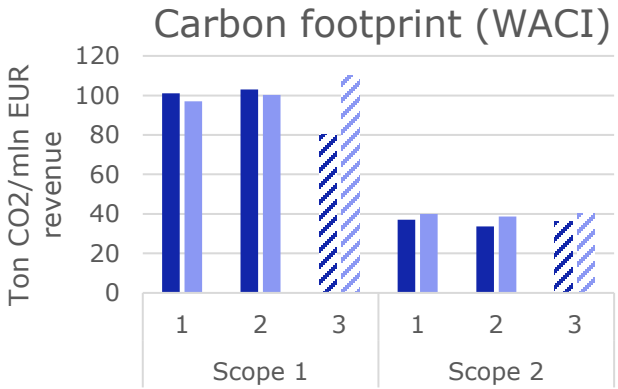
Look-through applied to carbon indicators





Case: Dutch pension funds invested in listed shares (in non-financial companies) 2021

Direct

Direct + indirect

Placeholder data

Look-through approaches: 1 "classic", 2 via supervision reporting, 3 "synthetic"

Scope 1 includes firm's own emissions, Scope 2 includes firm's emissions via energy purchase

- **Indirect holdings are very important**: Financed Emissions more than double upon inclusion of indirect investments; CFP remains similar, showing that carbon intensity of direct and indirect portfolio are comparable for Dutch pension funds

Conclusion & discussion

- We presented **three approaches** allowing us to "look-through" investments via funds, to obtain the indirect portfolio of the initial investor in the fund
- This is important in view of **risk assessments**, such as for carbon emission indicators
- The **look-through approach can be widely applied** to any financial sector, country, and in any risk assessment context
- Our **case study** shows that Financed Emissions double when indirect holdings are taken into account, which is important information for investors, supervisors and policy makers
- The three approaches have different features, each with their own advantages, and can be used independently of each other, or in a **hybrid fashion**

Approach	Domestic look-through	Foreign look-through
1) Classic	Coverage	No coverage
2) Supervisory	Coverage	Coverage
3) Synthetic	Modeled	Modeled
Hybrid (1 & 3)	Coverage	Modeled

Compare outcomes in IFC paper for NL case study!

Backup slides

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