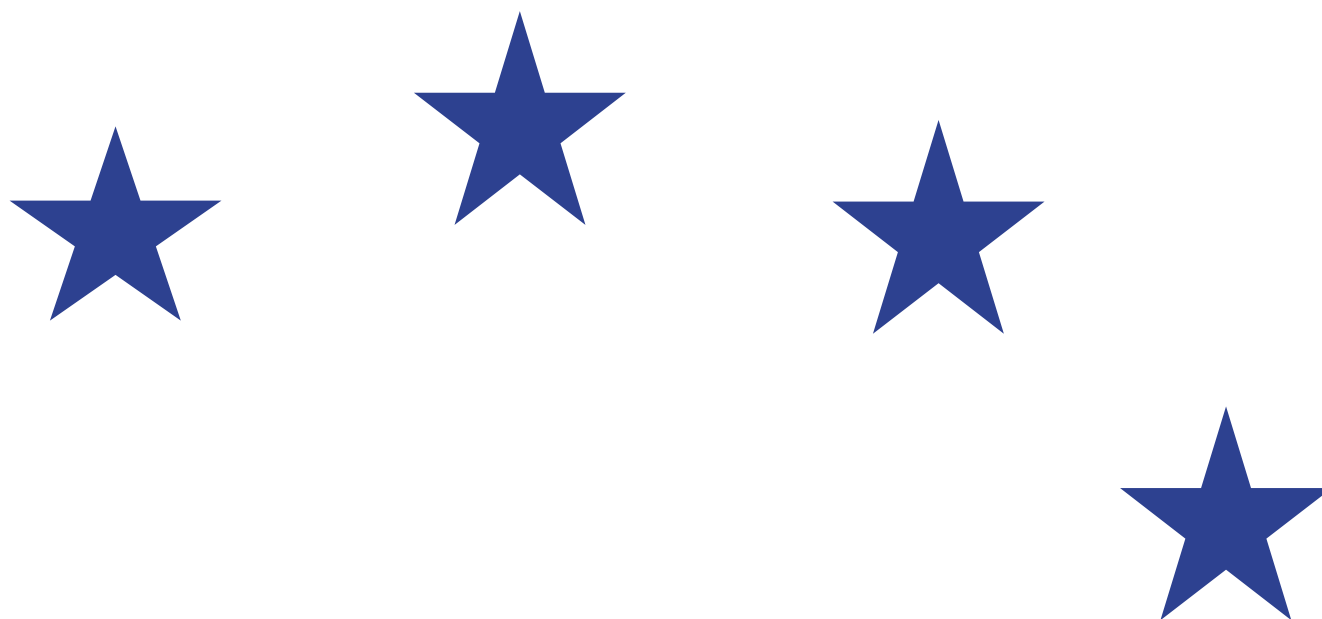


# Investment fund networks: a climate risk perspective

Adrien Amzallag, 15 April 2021





# Contents

- Overall idea:
  - Aim: set out some initial stylised facts to guide future deeper investigations
  - Big picture view: no distinction between ETFs, active vs. passive, etc.
  - Focus on transition risk for the moment
- Dataset and approach
- Network analysis
- Preliminary asset valuation exercise
- Next steps



## Overall idea

### Examine the network of fund portfolio holdings in terms of climate risk

- Detailed (ISIN-level) portfolio holdings data from Morningstar
- Fund-level data (e.g. domicile) from Morningstar
- Company (ISIN-level) balance sheet data ('emissions') from Refinitiv

### Why do this?

1. ESMA Regulation: Within ESMA's mandates + sustainable finance strategy
2. Single Rulebook: Need to prepare for ESMA climate risk stress tests
3. Challenge: first attempt to combine inv. funds + network analysis + climate risk



## Dataset and approach

### Some numbers

- Entities:
  - 23,352 EU-domiciled funds (79% are UCITS; 91% are active mgmt.)
  - 21,107 companies invested in by EU funds (anywhere in the world)
- Investments:
  - 3.2 million, worth EUR 8 trillion (51% of EU fund holdings)
    - o/w 2.1 million **direct** investm. in equities or corp. bonds
    - o/w 124k fund-to-fund investm. → an extra 12 million **indirect** exposures to equities or bonds
- Time: latest portfolio available at the time of download (during 2020)

#### RA.1

Portfolio holdings data set description

EU fund portfolio holdings by asset type

Asset type	Number of investments (thousands)	Value of investments (bn EUR)
Equities	1 321	3 019
Corporate bonds	811	1 319
Govt & supranational debt	280	1 166
Funds	124	1 061
Cash and cash equivalents	207	824
Structured finance	71	188
Derivatives	251	200
Real estate	50	98
Other	42	65
Commodities	1	2
Total	3 158	7 942

Note: 'Cash equivalents' comprises commercial paper, time deposits, certificates of deposit, and cash set aside to offset forwards, options, repurchase agreements, swaps or futures. 'Derivatives' comprises futures, forwards, swaps, options and CfDs. 'Other' comprises bank loans, infrastructure assets, 'Other assets and liabilities', and 'Undefined'.

Sources: Morningstar, Refinitiv, ESMA.



Network analysis

## Inspecting fund exposures

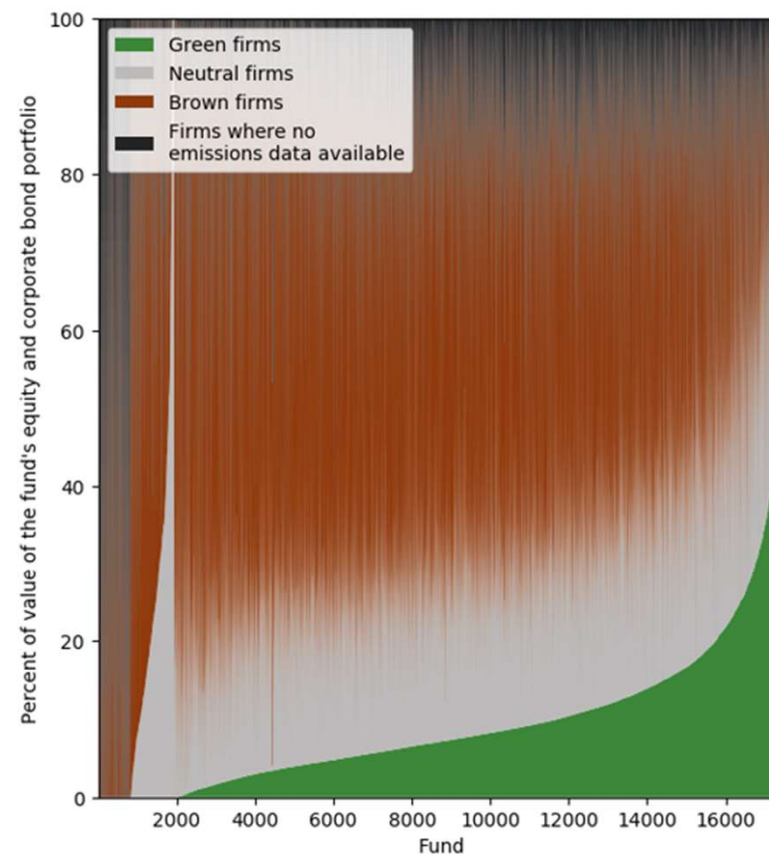
### Measuring green and brown firms

- Have emissions data for c. 81% of funds' equity and corp. bond holdings
- Classify firms by amount of emissions
  - **green**: firms in lowest third
  - **brown**: firms in highest third
  - **neutral**: firms in between
  - **no data**
- Use total CO2 and CO2 equivalent emissions in tonnes (scope 1 and 2): *CO2, methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCS), perfluorinated compounds (PFCS), sulphur hexafluoride (SF6), nitrogen trifluoride (NF3)*
- Question: what is the relative % of funds' equity and bond portfolio exposure to these firms?

RA.4

Share of portfolios in green vs brown firms

EU fund portfolios underweight green firms



Note: The chart displays the percentage (in terms of value) of each individual fund's equity and corporate bond portfolio (y-axis) that is allocated to firms classified according to their portfolio emissions. Portfolio percentage exposures are split into the following four categories: firms whose emissions are below the 33rd percentile for the data sample ('green' firms); firms whose emissions are greater than or equal to the 67th percentile ('brown' firms); firms whose emissions are in between these groups (i.e. the 33rd percentile and the 67th percentile; 'neutral' firms); and also firms for which no emissions information is available. The x-axis denotes individual funds, sorted according to the percentage of exposures to green firms in the portfolio (from lowest to highest share).

Sources: Morningstar, Refinitiv, ESMA.



## Comparing funds using portfolio 'dirtiness'

**Aim:** build a bottom-up measure to compare funds with each other

**1. Preferred measure: weighted average emissions per investment in portfolio**

- a) Use amount of investment in each company as weights
- b) Apply a look-through approach to investments in other funds

$$\sum_{i=1}^N \left( \frac{\text{current value of investment}_i}{\text{current portfolio value}} \times \text{company CO}_2 \text{ emissions}_i \right)$$

**2. Alternative:** W. avg. carbon footprint (as above; normalise emissions by revenue)

- a) Reflects fund strategy (e.g. investment mandate may oblige holding only instruments from investment-grade firms, which are usually larger)
- b) Reflects also constraints: green firms might issue fewer purchasable instr.
- c) ...***but does not fully reflect actual damage a fund portfolio is causing***



Dataset and approach

## Comparing funds

### Which funds have the most damaging portfolios?

i.e. what does it mean for a fund to be “environmentally damaging”?

The most damaging funds are here

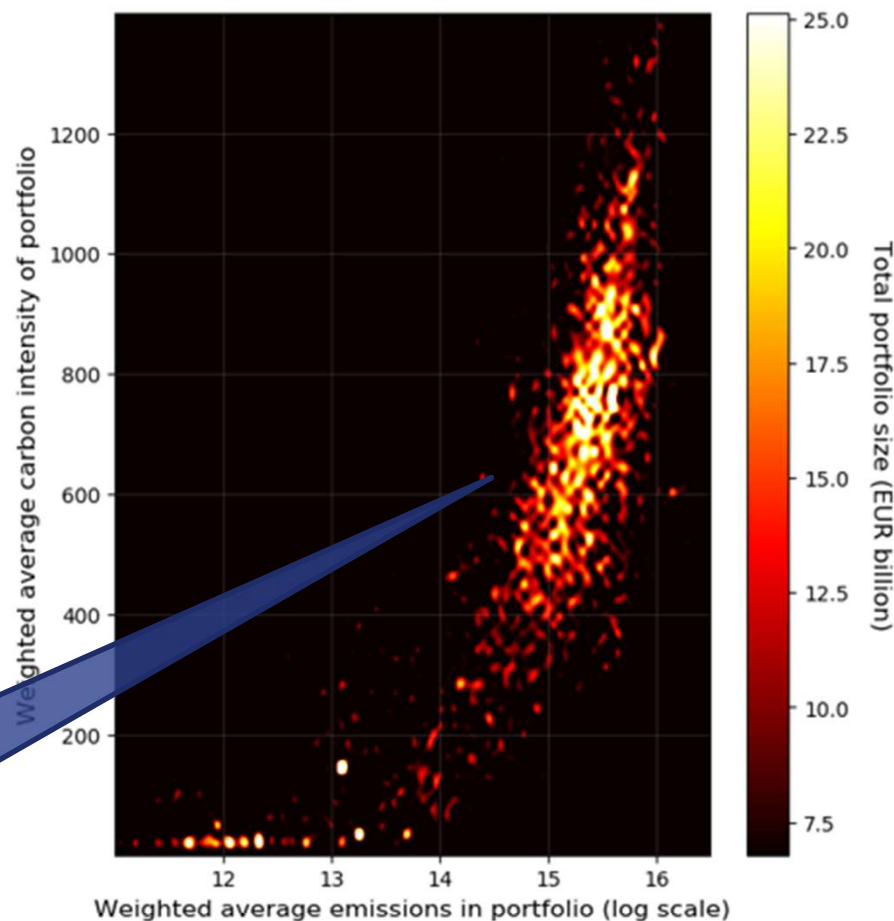
These are funds with:

1. the largest portfolios and
2. high-emission portfolios and
3. high carbon footprint portfolios

RA.5

Comparing fund portfolios across climate risk metrics

Which fund portfolios are most damaging?



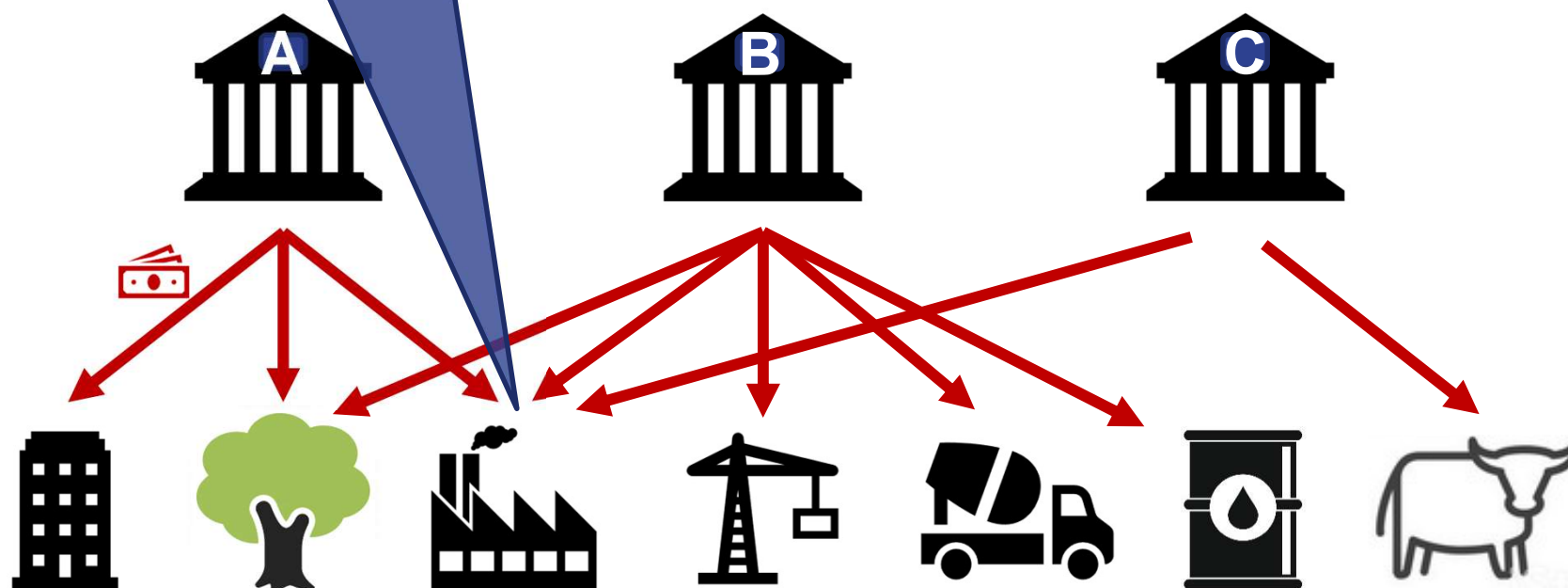
Note: The x-axis is the average emissions within each fund portfolio (weighted by value of each investment position) and in log scale. The y-axis is the average carbon footprint (tonnes of CO<sub>2</sub>-equivalent per m EUR revenue, measured as EBITDA) of investments within each fund portfolio (weighted by the value of each investment position). The colour scale (right) illustrates the total size of each fund's portfolio, measured in bn EUR. Higher asset sizes are paler. Includes direct (scope 1) and indirect (scope 2) CO<sub>2</sub> and CO<sub>2</sub>-equivalent emissions.

Sources: Morningstar, Refinitiv, ESMA.



## Perspectives for thinking about this network

Access to finance perspective: how many funds are investing in this firm, and who are they?



Investments





Network analysis

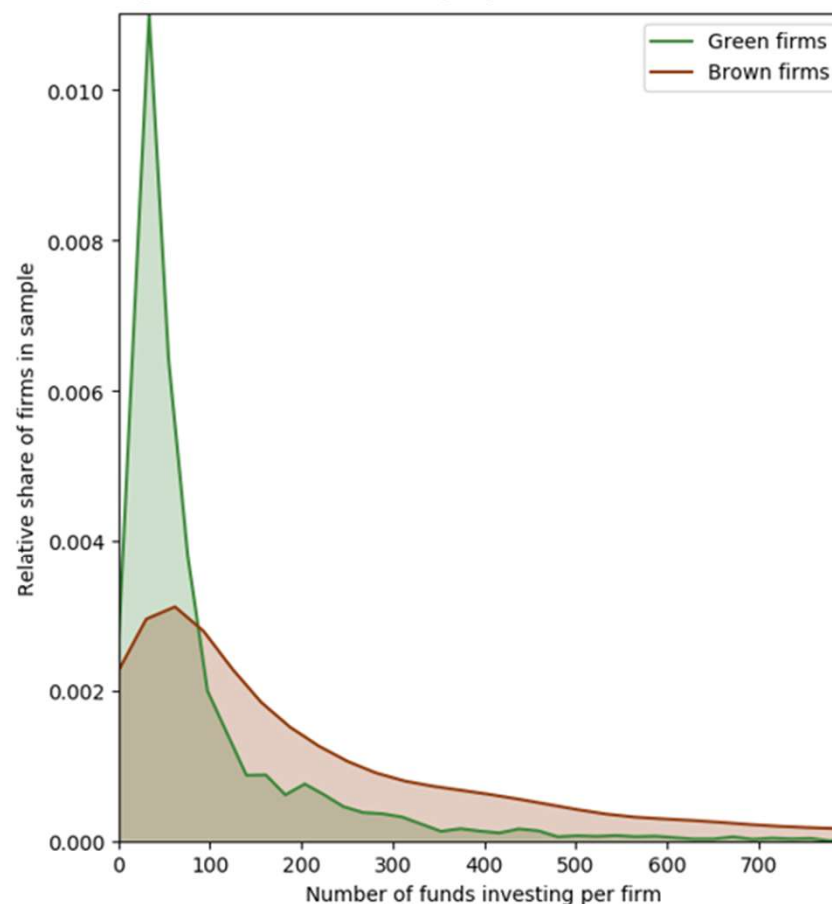
## Examining this network

### Initial distribution of shocks

- Hypothesis 1: **brown** firms more vulnerable to climate risks
- Hypothesis 2: climate risk shocks are likely to be 'large'
- Question: are **brown** firm equities and bonds sold to more funds than **green** firm assets?
- If yes (+ hypotheses 1 and 2): disproportionate impact of climate risk shocks on fund portfolio network

RA.6

Comparing the number of fund investments per firm  
Polluting firms are more popular



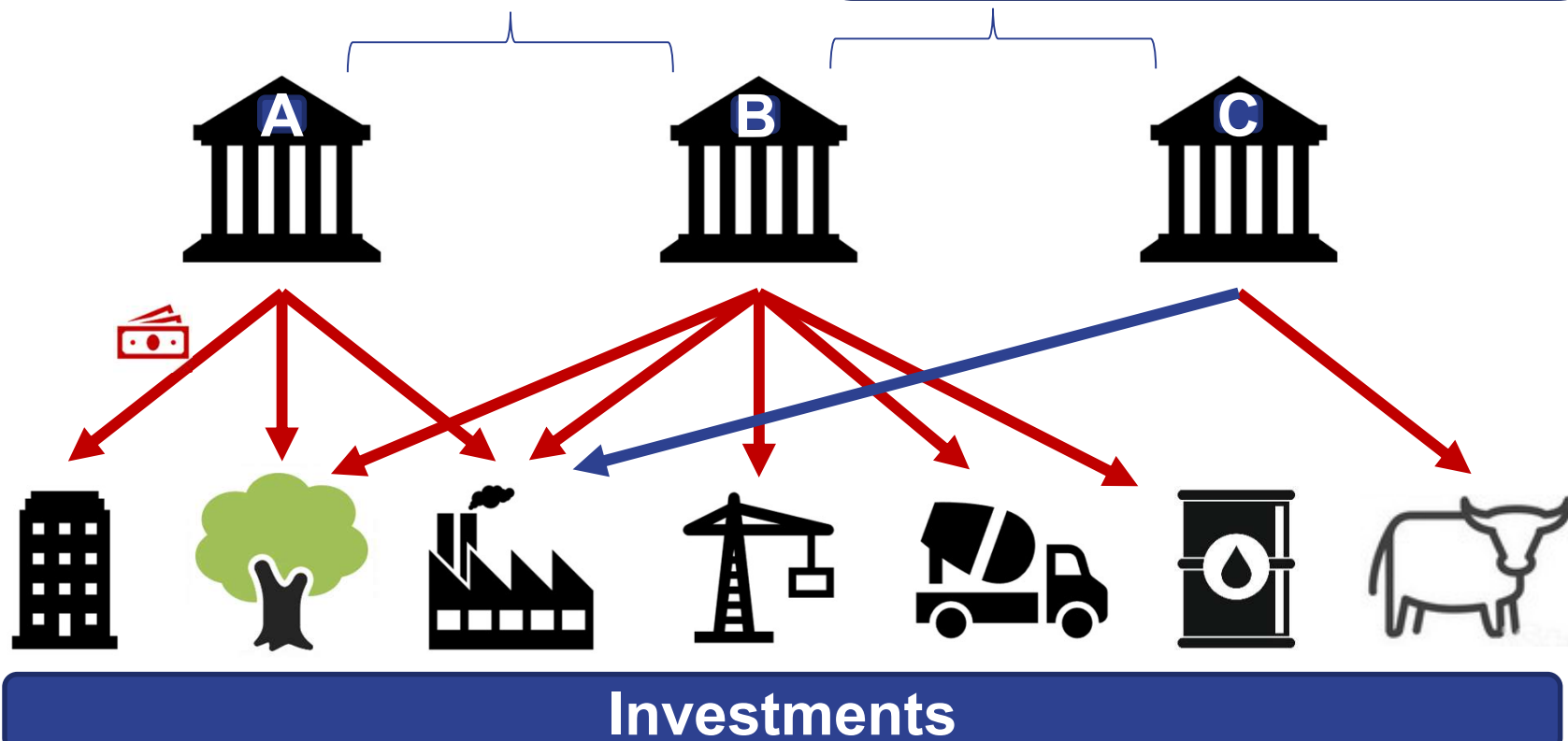
Note: The lines represent the distribution of the number of funds directly investing in each firm (relative to total number of investments, i.e. the normalised degree of each firm), for firms that are in the bottom third in terms of emissions ('green' firms) or in the top third ('brown' firms). Emissions are of total CO<sub>2</sub> and CO<sub>2</sub>-equivalent emissions including direct (scope 1) and indirect (scope 2) emissions. The two distributions are different with at least 97 % confidence according to a two-sample Kolmogorov–Smirnov test. Distributions are truncated at the 90th percentile for ease of visualisation.

Sources: Morningstar, Refinitiv, ESMA.

## Considering portfolio similarity across pairs of funds

Fund A and fund B have 2 investments in common. Funds A and B's combined portfolio spans 6 unique investments. So funds A and B have a 33% portfolio overlap.

Fund B and fund C have 1 investment in common. Funds B and C's combined portfolio spans 6 unique investments. So funds B and C have a 17% portfolio overlap.





## Examining this network from a climate perspective

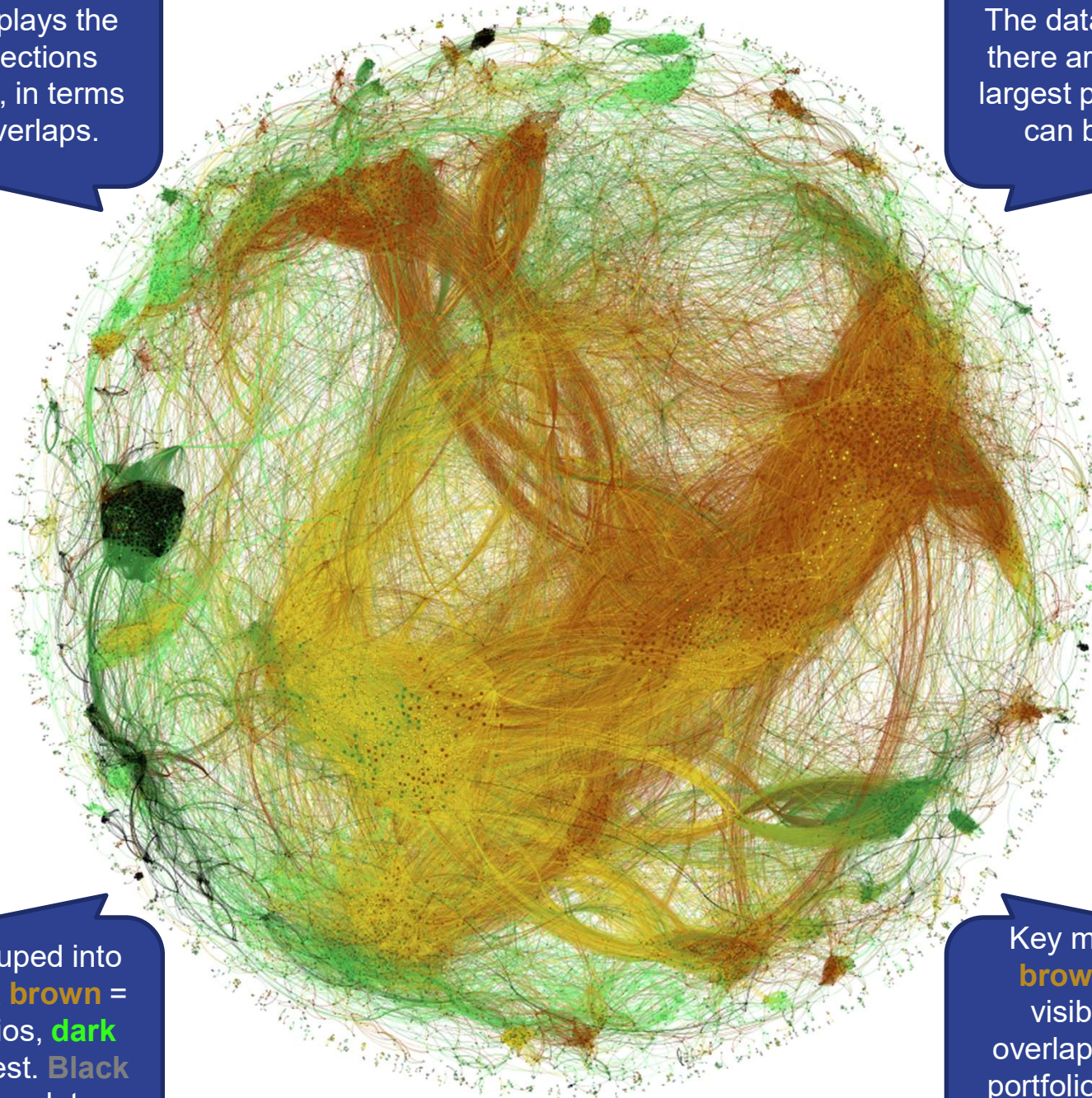
### Co-movement in fund portfolios following climate shocks

- More similar portfolios → less diversification
- Question 1: how similar are the **dirtyest** portfolios with each other?
- Question 2: are the **dirtyest** portfolios more similar to each other than the portfolios for pairs of the **cleanest** fund pairs?
  - Answer appears to be **‘Yes’**
  - Implies greater potential for fund ‘herding’ in asset buying or selling
- Why is this important to check? Portfolio similarity & portfolio dirtiness are not necessarily correlated.
  - Two funds can have identical ‘dirtiness’ yet invest in completely different companies
  - Can therefore use portfolio similarity/overlap as a measure of interconnection between funds



This figure displays the indirect connections between funds, in terms of portfolio overlaps.

The dataset is massive: there are only the 0.5% largest portfolio overlaps can be visualized!



Funds are grouped into quartiles. **Dark brown** = dirtiest portfolios, **dark green** = cleanest. **Black** = no emissions data.

Key message: more **brown & yellow** is visible → greater overlaps between dirty portfolios than between clean portfolios



First indications of asset management sector losses due to climate risk

## What does vulnerability to climate risk imply?

### Asset valuation exercise

- Apply energy transition risk scenarios in ESRB (2020), from Vermeulen et al. (2018)
- Shock drivers (impact is sector-specific):
  1. abrupt implementation of stringent policies to mitigate climate change
  2. tech breakthroughs that lower CO2 emissions but disrupt economy (creative destruction)
- Time horizon: 5 years

RA.9

Forward-looking climate risk scenario analysis

First-round EU fund losses in each climate risk scenario

Scenario	Average asset write-downs (%)	Total losses (bn EUR)	Total losses (% of fund assets included)
Policy shock	5.2	242	4.9
Tech shock	3.3	152	3.1
Policy + tech shock	9.7	443	9.0
Confidence shock	7.5	356	7.2

Note: Application of energy transition risk asset valuation scenarios to EU fund equity holdings, based on scenarios developed by Vermeulen et al. (2018) and employed by ESRB (2020). Average write-downs are weighed by total value of investments used in the asset valuation exercise. Percentages are expressed in terms of total portfolio holdings of equity, corporate bonds and shares issued by other investment funds. Indirect holdings are also included, i.e. we record losses on fund investments in other funds that are exposed to markdowns in asset values. The UK and the Channel Islands are included in this sample.

Sources: ESRB (2020) Vermeulen et al. (2018), Morningstar, Refinitiv, ESMA.





First indications of asset management sector losses due to climate risk

## Which funds are most vulnerable to climate shocks?

### Impact of policy + tech shock across funds

- The **dirtier** the fund portfolio, the greater the exposure to climate risk-related losses
- Some clean funds can even fully escape the climate shock

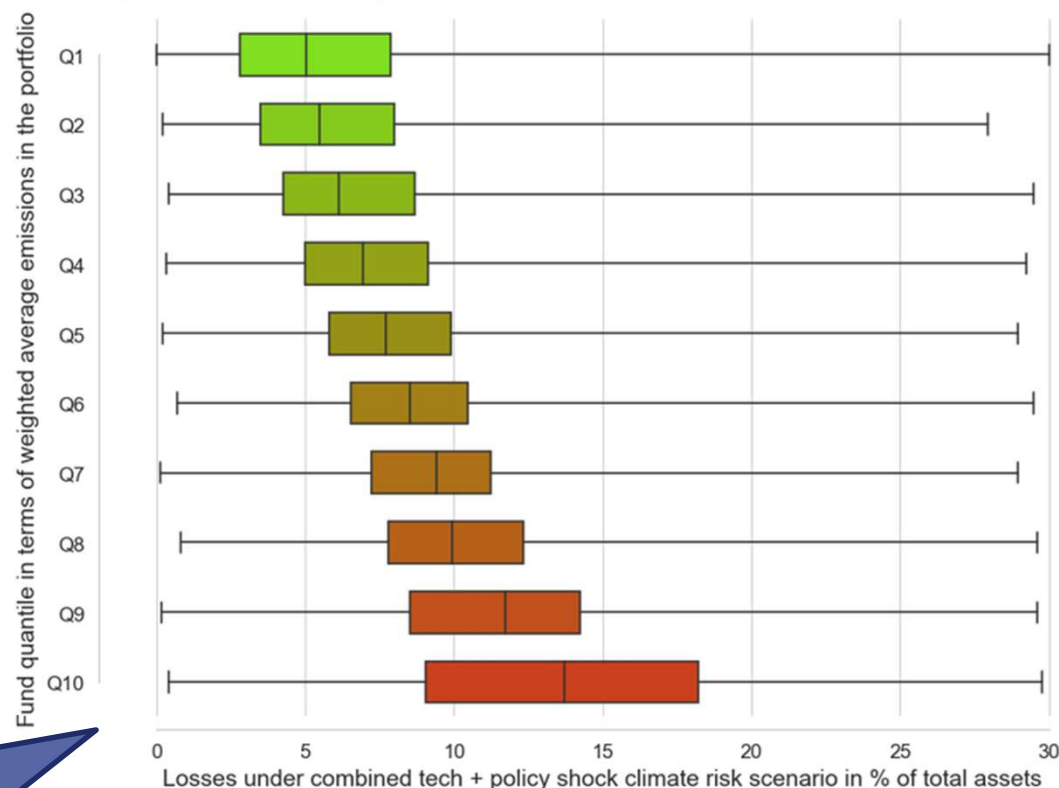
#### Example of how to read this chart

For funds whose portfolio emissions are in the 10<sup>th</sup> decile, losses under a combined policy & tech climate shock usually range from c. 9 to 18% of assets included, and in extreme cases can be as low as 0.5% and as high as c.30% of assets included.

RA.10

Forward-looking climate risk scenario analysis

Cleaner portfolios are more protected



Note: Application of energy transition risk asset valuation scenarios to EU fund equity and corporate bond holdings, based on the combined tech and policy shock scenarios developed by the DNB (2018) and employed by the ESRB (2020). Each set of distributions displays the range of losses, as a percentage of total portfolio holdings of equity, corporate bonds and shares issued by other investment funds, for funds within the respective quantile (quantiles determined based on each fund's average emissions per investment, weighted by value of each investment position) across funds recorded as domiciled in Europe. Emissions are recorded as CO<sub>2</sub> and CO<sub>2</sub>-equivalent emissions (scopes 1 and 2). The vertical black line in each box shows the median percentage loss for funds in that emissions quantile. Box edges are the 25th and 75th percentiles of the fund losses for funds in that emissions quantile, and additional lines ('whiskers') illustrate the percentage losses that are either below the 25th or above the 75th percentiles for funds in that emissions quantile, reaching to the 10th and 90th percentiles. Indirect holdings are also included, i.e. we record losses on fund investments in other funds that are exposed to markdowns in asset values. The UK and the Channel Islands are included in this sample.

Sources: DNB (2018), Morningstar, Refinitiv, ESMA.



First indications of asset management sector losses due to climate risk

## Which funds contribute the most to system losses?

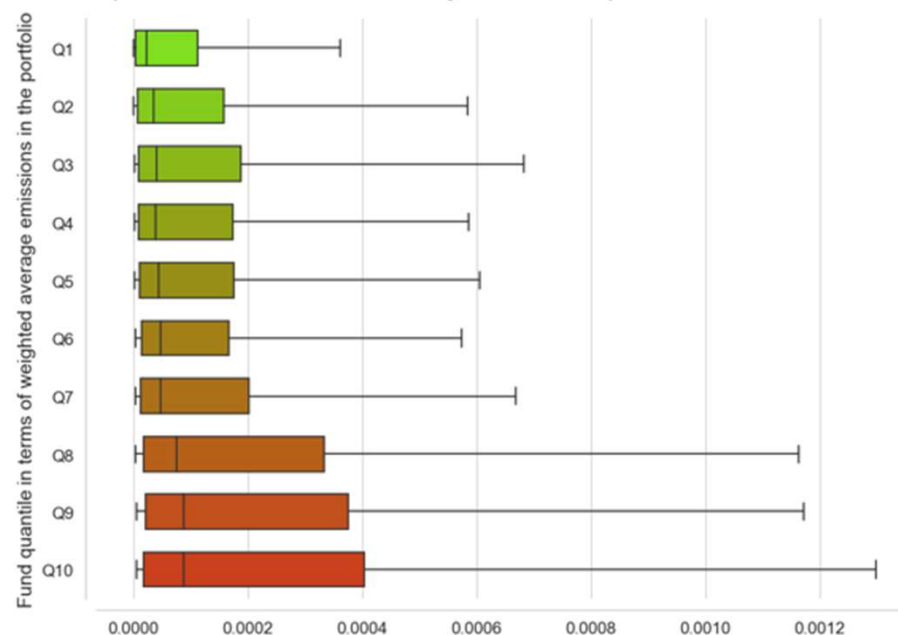
### System-wide impact

- **Dirtier** fund portfolios make a greater contribution to overall system-wide losses than **clean** fund portfolios
- Provides further evidence on earlier theme: **dirtier** fund portfolios are more systemically important (interconnected) than **clean** fund portfolios
- *Policy/supervisory implication:* the dirtier a fund portfolio, the more policymakers & supervisors may wish to monitor it from a (long-term) financial stability perspective

RA.11

Contribution of each fund to system-wide losses

Brown portfolios have more systemic impact



contribution to system-wide losses under combined tech + policy shock climate risk scenario, % of system assets

Note: Application of energy transition risk asset valuation scenarios to EU fund equity and corporate bond holdings, based on the combined tech and policy shock scenarios developed by the DNB (2018) and employed by the ESRB (2020). Each set of distributions displays the contribution to system-wide losses, as a percentage of total system assets included in the scenario exercise (equity, corporate bonds and shares issued by other investment funds), for funds within the respective quantile (quantiles determined based on each fund's average emissions per investment, weighted by value of each investment position) across funds recorded as domiciled in Europe. Emissions are recorded as CO<sub>2</sub> and CO<sub>2</sub>-equivalent emissions (scopes 1 and 2). The vertical black line in each box shows the median percentage loss for funds in that emissions quantile. Box edges are the 25th and 75th percentiles of the fund losses for funds in that emission quantile, and additional lines ('whiskers') illustrate the percentage losses that are either below the 25th or above the 75th percentiles for funds in that emissions quantile, reaching to the 10th and 90th percentiles. Indirect holdings are also included, i.e. we record losses on fund investments in other funds that are exposed to markdowns in asset values. The UK and the Channel Islands are included in this sample.

Sources: DNB (2018), Morningstar, Refinitiv, ESMA.





## What we have observed so far re: climate risk and funds

### Risk identification: is EU fund universe tilted towards climate risk vulnerability?

- Initial source of shock: **more polluting** companies sell assets to a broader number of funds (**less polluting** companies sell assets to a smaller number of funds)
- Possibility for co-movement: funds with **more polluting** portfolios are have more similar portfolios with each other than pairs of **clean** portfolio funds

### Risk assessment: (long-term) impact of climate risk on funds is non-negligible

- Funds face 3-9% losses in recent climate risk scenarios (ESRB 2020)
- But this is unevenly distributed: **cleanest funds** face 3-8% losses while **dirtiest funds** face 9-18% losses and contribute the most to system-wide losses
- Some positive news: funds holding portfolios that are clean can largely escape
- NB: These are lower-bound estimates (old scenarios, missing some benchmarks)

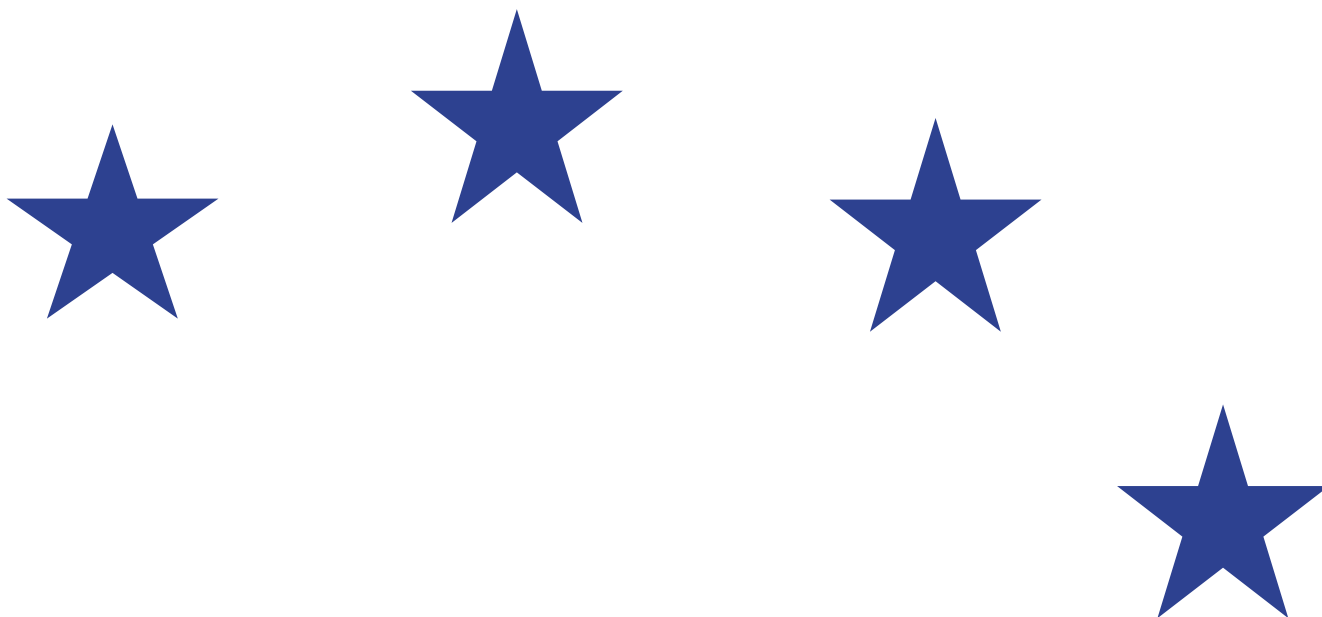
### Extensions under consideration :

- Update scenarios (e.g. NGFS scenarios)
- What to do with firms that do not report emissions data (e.g. penalize with sector max?)
- Include public sector assets & real estate assets
- Use broader definition of emissions (Scope 3, plus also NOx, SOx, VOC, Water, etc.)
- Consider fund adaptation effects
- Introduce a time series dimension (measure evolution in vulnerability)



Thank you

## Background slides





Network analysis

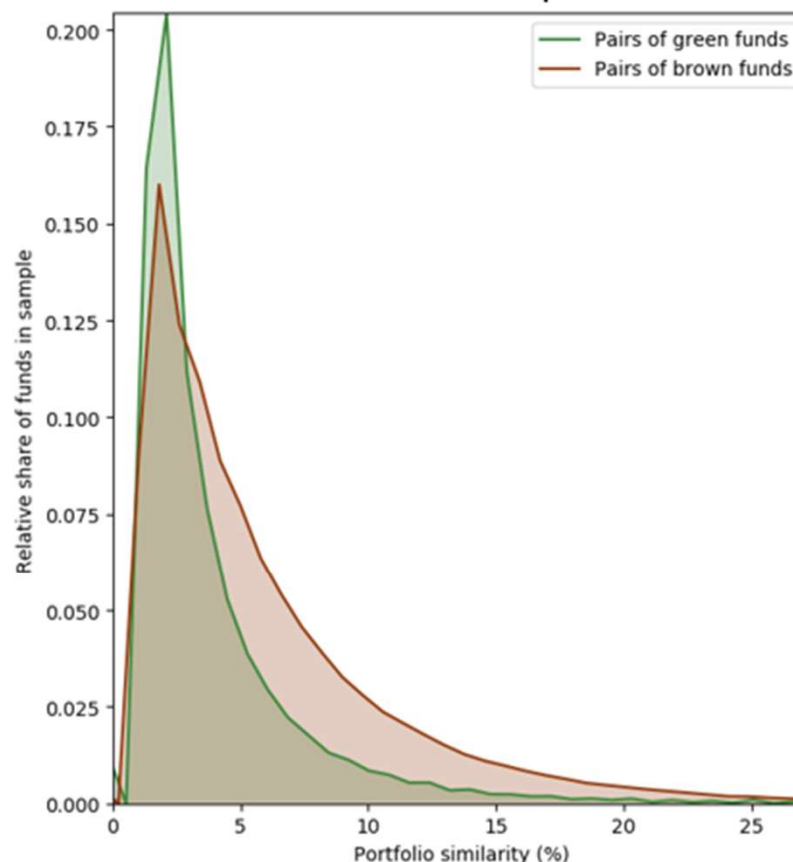
## Examining this network

### Shock distribution

- More similar portfolios → more co-movement likely after a common shock
- Question 1: how similar are the **dirtiest** portfolios with each other?
- Question 2: are the **dirtiest** portfolios more similar to each other than the portfolios for pairs of the **cleanest** fund pairs?
- If yes to Q2: implies climate risk shocks will affect more funds at the same time
- Key insight: portfolio similarity & dirtiness are not necessarily correlated.
  - Two funds can have identical 'dirtiness' yet invest in completely different companies (i.e. 0% portfolio overlap → no interconnection)

RA.7

Extent of overlapping portfolios across pairs of funds  
Brown funds have more similar portfolios

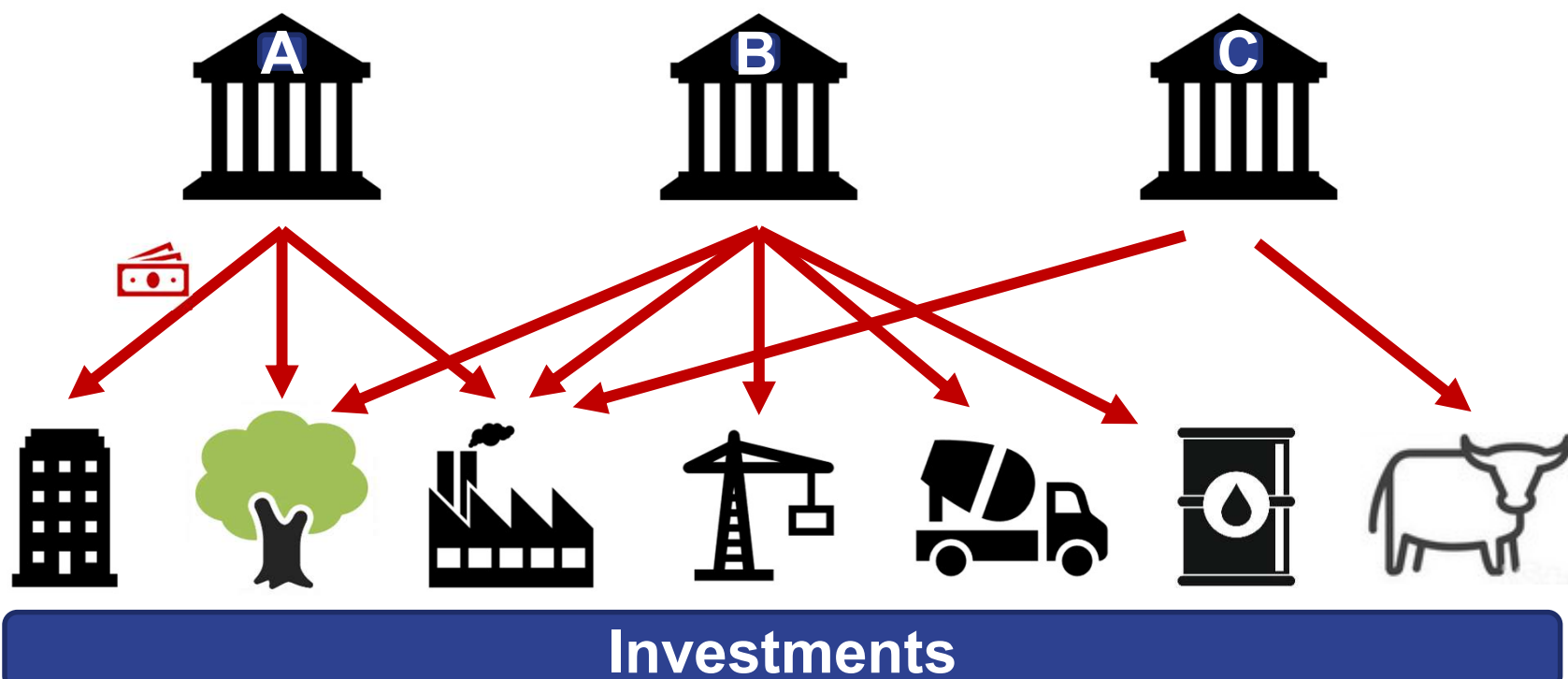


Note: The lines represent the distribution of portfolio similarity across pairs of investment funds (in %). Two sets of pairs are shown: pairs of funds each of whose portfolios are in the bottom third in terms of weighted average emissions ('pairs of green funds') and pairs of funds whose portfolios rank in the top third in terms of weighted average emissions ('pairs of brown funds'), based on the fund portfolio holdings data set. Portfolio similarity is expressed as the number of common investments between each pair of funds, normalised by the total number of firms considered by either the two funds. Emissions are CO<sub>2</sub> and CO<sub>2</sub>-equivalent emissions (scopes 1 and 2 included). The two distributions are different with at least 99 % confidence according to a two-sample Kolmogorov–Smirnov test.

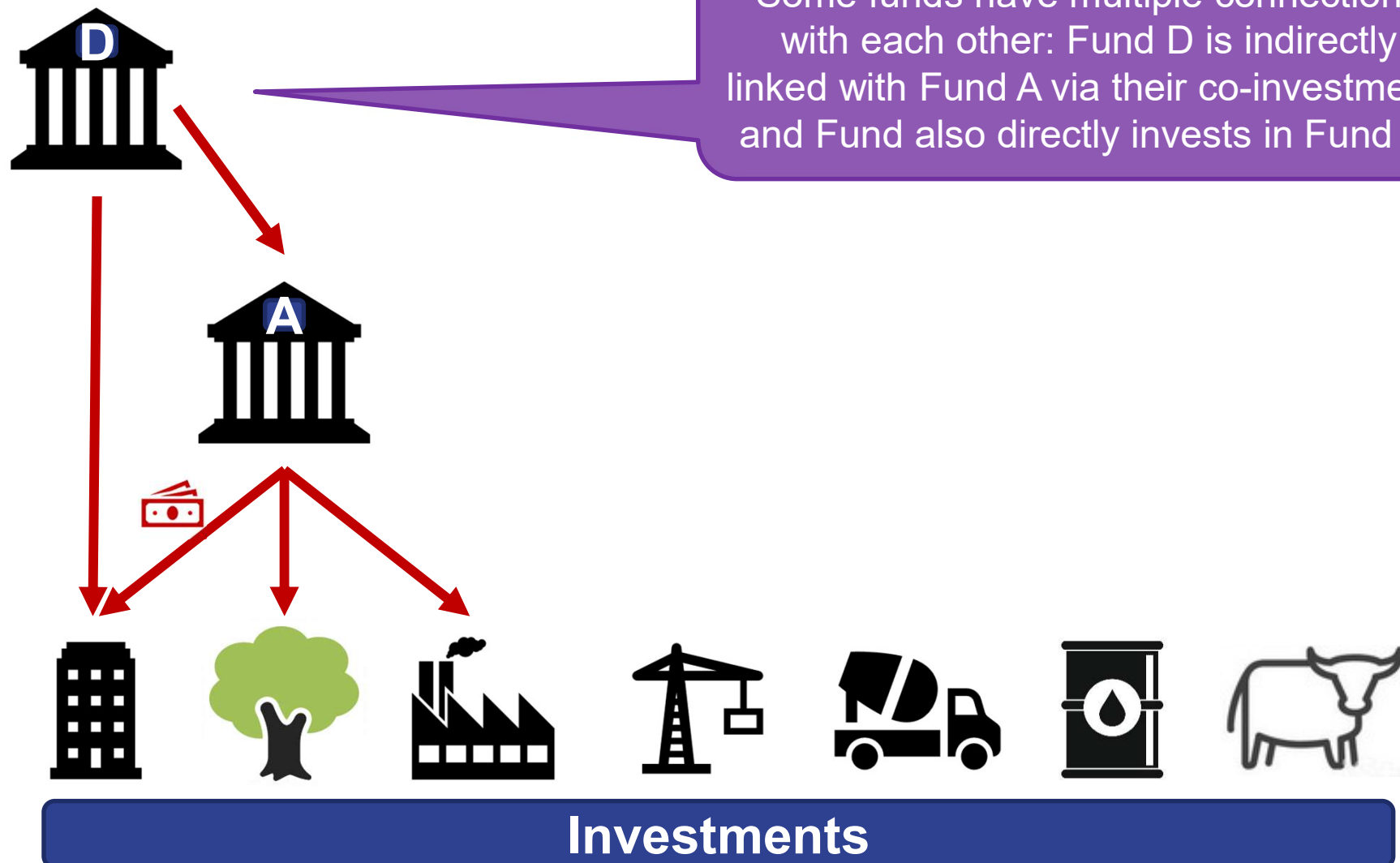
Sources: Morningstar, Refinitiv, ESMA.

## Perspectives for thinking about this network

Indirect links between funds: what is the overlap in portfolios across funds? E.g. Funds B and A share investments in two companies. Funds B and C share investments in one company.

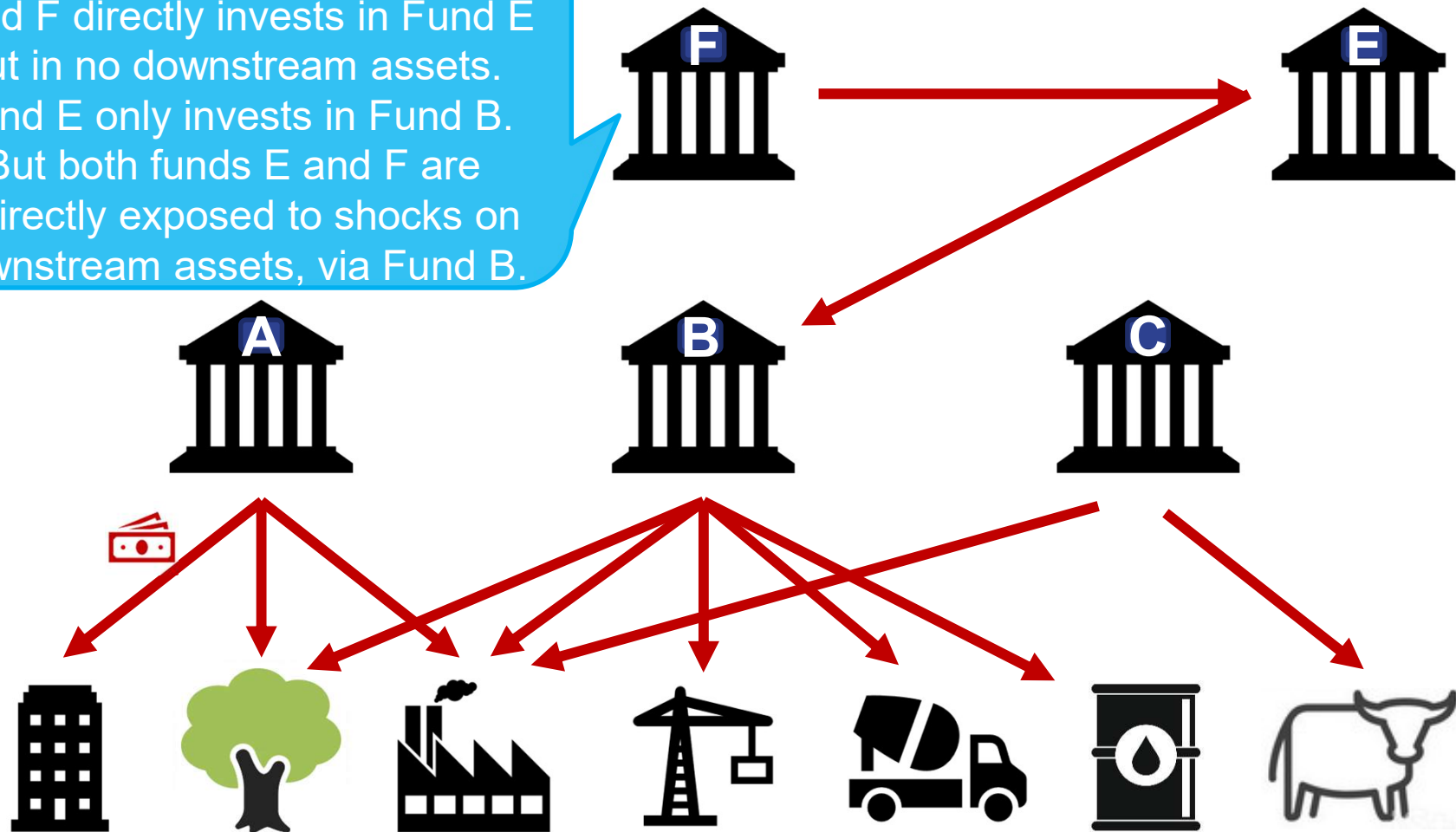


## Perspectives for thinking about this network



## Perspectives for thinking about this network

Other relationships are possible:  
Fund F directly invests in Fund E  
but in no downstream assets.  
Fund E only invests in Fund B.  
But both funds E and F are  
indirectly exposed to shocks on  
downstream assets, via Fund B.



Investments