

# Intelligence artificielle pour la finance durable : réalités et défis

Mardi 17 octobre

Auditorium du Medef, 55 avenue Bosquet, 75007 Paris

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# Intelligence artificielle pour la finance durable : réalités et défis

**Marie Brière** (Amundi, AFG et programme FaIR  
de l'Institut Louis Bachelier)



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# Intelligence artificielle pour la finance durable : réalités et défis

IA, données alternatives et ESG: perspectives académiques

**Elise Gourier (ESSEC)**

*Détection de greenwashing à partir de données textuelles*



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# A Greenwashing Index

Elise Gourier

ESSEC & CEPR

Hélène Mathurin

ESSEC

Séminaire IA / AFG-FaiR ILB

17 octobre 2023

# What Is Greenwashing?

## E.U. Taxonomy Regulation (financial sector)

Defines greenwashing as "the practice of gaining an unfair competitive advantage by marketing a financial product as environmentally friendly, when in fact basic environmental standards have not been met"

### Is Greenwashing a big deal?



The screenshot shows the top navigation bar of the European Commission website. On the left is the European Commission logo. In the center, there is a language selector set to "English EN" and a search bar. Below the navigation bar is a blue header area with the breadcrumb "Home > Press corner > Screening of websites". A language selector shows "Available languages: English". Below that, it says "Press release | 28 January 2021 | Brussels". The main headline in large white text reads: "Screening of websites for 'greenwashing': half of green claims lack evidence".

# Where Is There Greenwashing?

## EU regulators flag rising greenwashing practices by banks

European Banking Authority says there is a 'clear increase' in financial institutions overstating their climate credentials



EU regulators are also due to report in a year's time on how their supervisory powers could be extended to tackle greenwashing more effectively © Krisztian Bocsi/Bloomberg

Kenza Bryan in London and Alice Hancock in Brussels JUNE 1 2023

17

Boards, Policy & Regulation | Securities Enforcement | ESG Regulation | ESG Investors | Regulatory Oversight

## US SEC cracks down on funds "greenwashing" with new investment requirement

By Douglas Gillison and Michelle Price

September 20, 2023 6:35 PM GMT+2 · Updated 21 days ago

|

# Contribution

- We use news articles to measure market participants' attention to greenwashing

*Engle, Giglio, Kelly, Lee and Stroebe (2020)*

- We build two greenwashing indices:
  - Overall importance of greenwashing in the news  
*If investors are concerned about greenwashing, the more they read about it in the news, the more it may affect their investment behaviour.*
  - Fraction of attention to climate risk that is in fact attention to greenwashing  
*The larger this fraction, the more greenwashing impairs the measurement and hedging of climate risk.*
- We study the composition of these indices (sectors, topics)
- Does greenwashing command a risk premium?

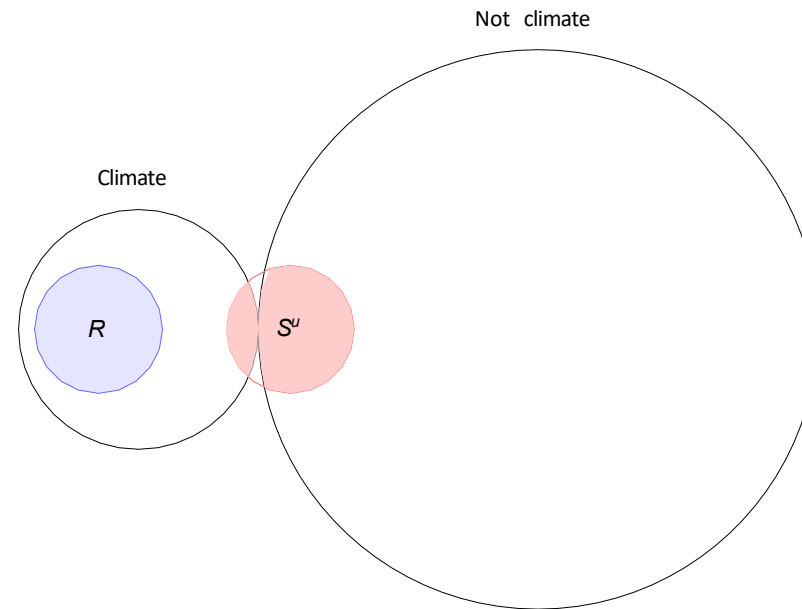
# Findings

- ① Attention to greenwashing has been steadily increasing since mid-2018.
- ② It reached nearly 10% of attention to climate risk.
- ③ This increase was driven by concerns about the financial sector (ESG investments, green bonds and ESG ratings).
- ④ Main items of concern are disclosure and emissions.
- ⑤ Greenwashing commands a positive and significant risk premium.

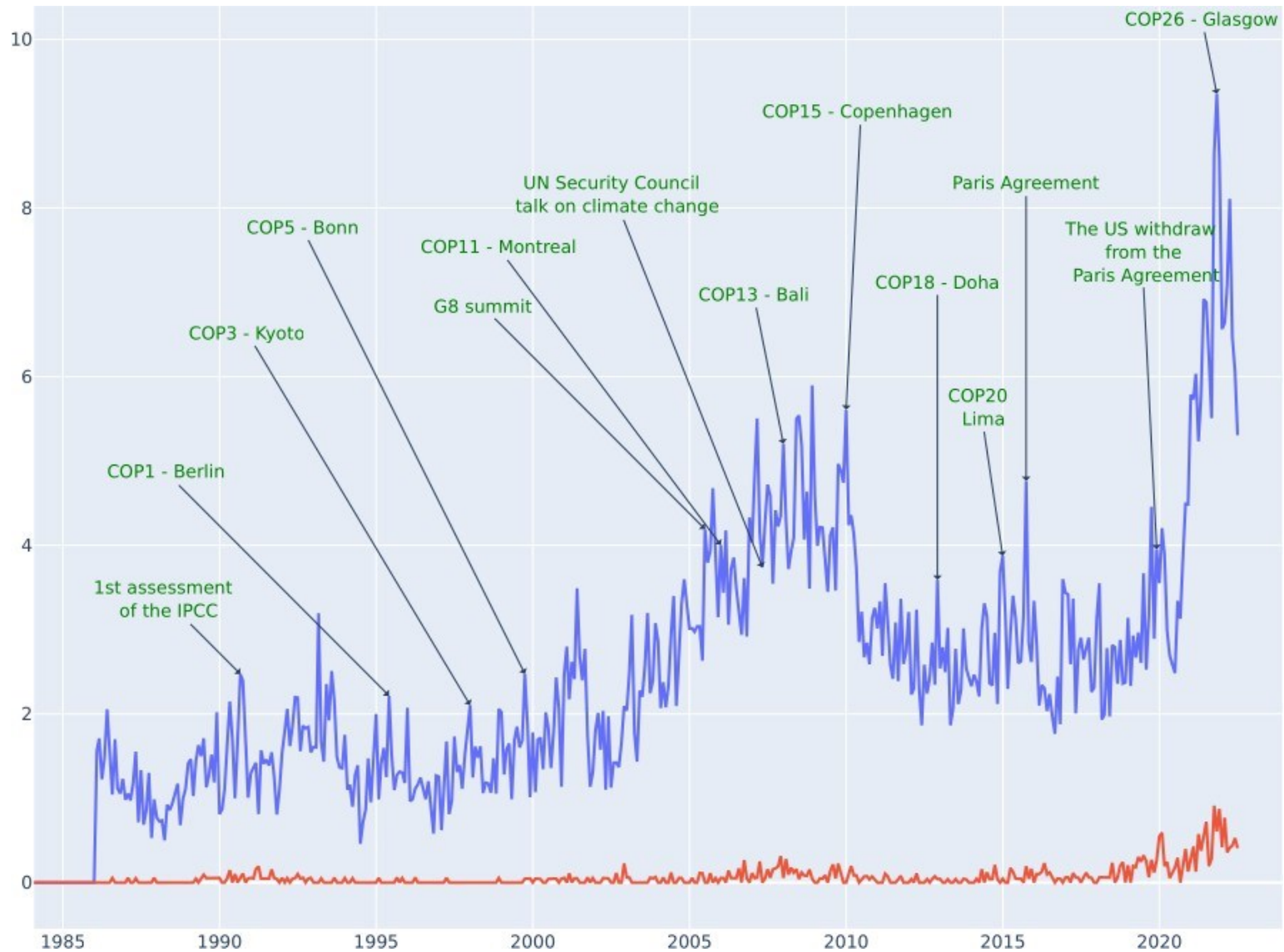


# Algorithm

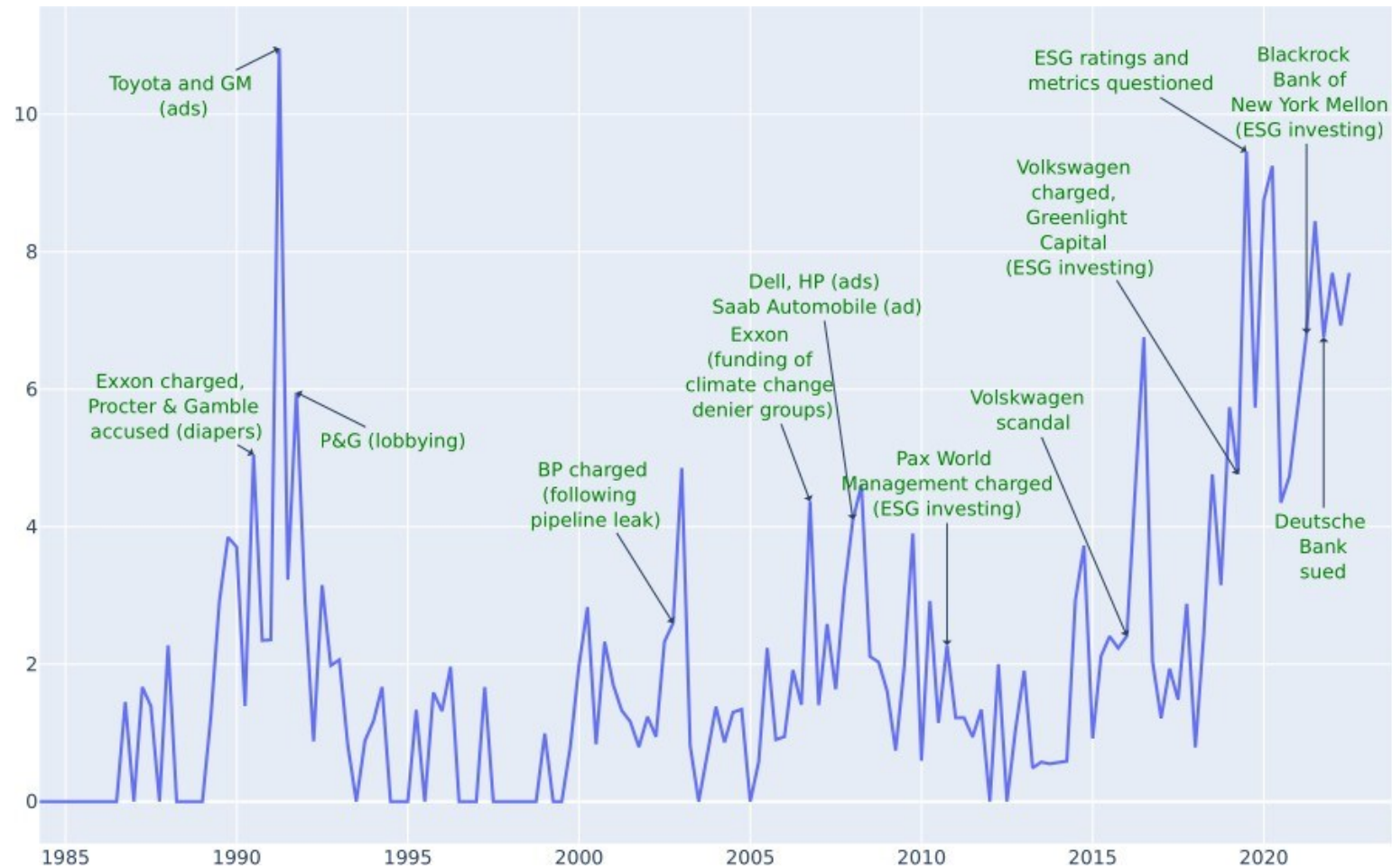
- Daily paper-based Wall Street Journal articles from January 1979 to December 2021 (nearly 1m)
- Semi-supervised algorithm that iteratively discovers and classifies documents
- Hand-labelled 1479 articles for validation and testing
- Our method achieves remarkable results in terms of out-of-sample accuracy.



# Overall Importance of Greenwashing



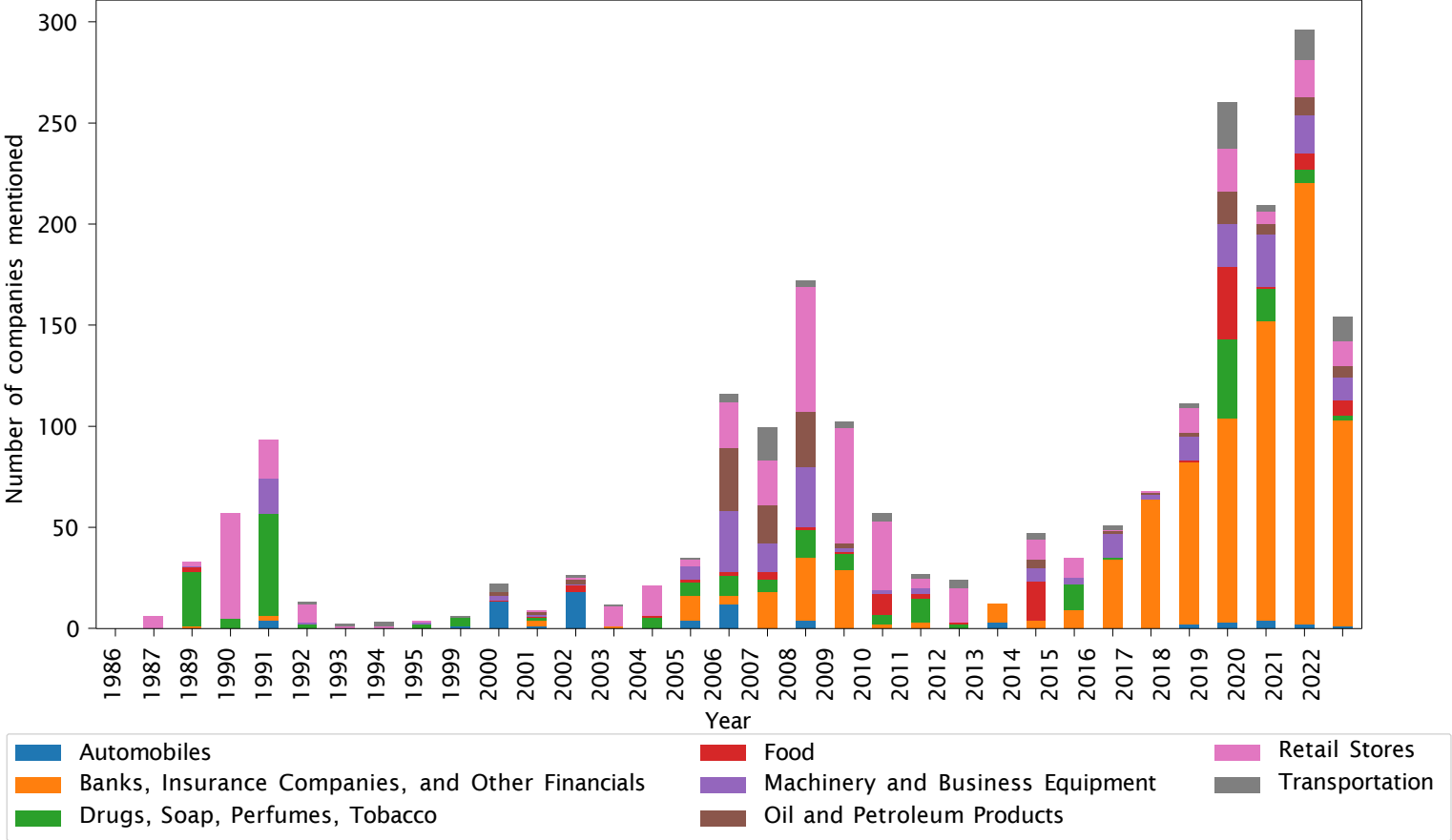
# Greenwashing Relative to Climate Risk



- Before 2018: greenwashing mostly < 5% climate risk discussion
- Since 2018: around 8%.

# Firms and industries

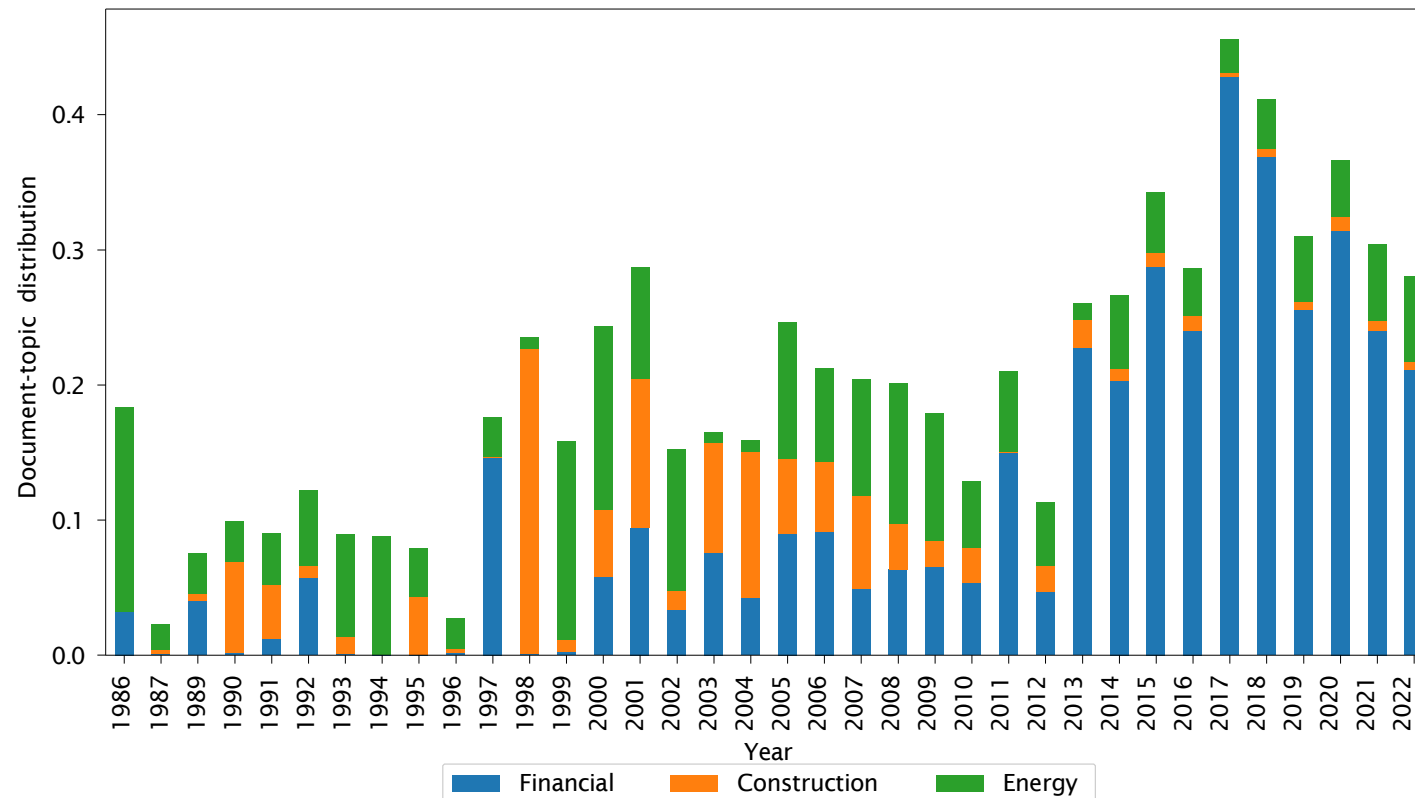
Named Entity Recognition + Entity Linking using Wikidata



# Topics

Keyword Assisted Topic Model (keyATM) introduced by Eshima, Imai, and Sasaki (2023)

- Most important topic: disclosure (shown to be a driver of greenwashing, Deegan, 2002)
- Second most important: asset management (investment, asset, etc...)

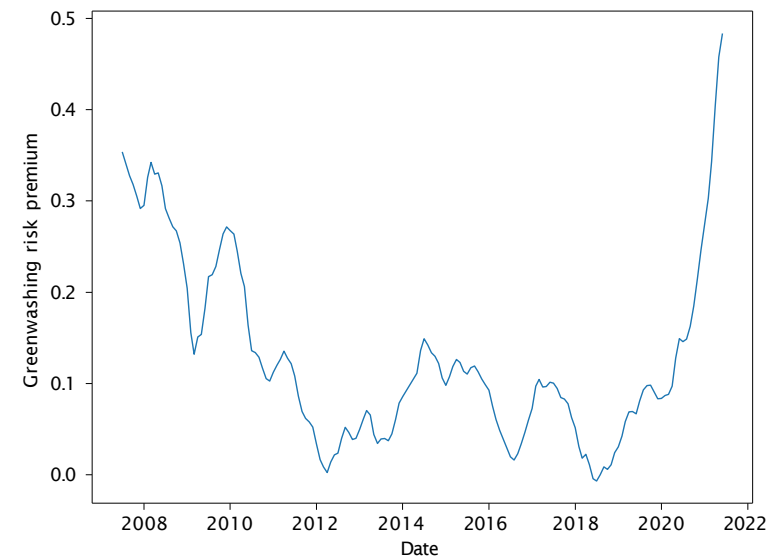


# Does Greenwashing Impact Returns?

- Fama MacBeth regressions
- 6-factor model:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,t}^{clim} CI_t + \beta_{i,t}^{gw} GI_t + \beta_{i,t}^{Mkt} Mkt_t + \beta_{i,t}^{SMB} SMB_t + \beta_{i,t}^{HML} HML_t + \beta_{i,t}^{RMW} RMW_t + \beta_{i,t}^{CMA} CMA_t + \beta_{i,t}^{Mom} Mom_t + \epsilon_{i,t}$$

	RET	
Greenwashing (GI)	0.151	(0.023)
Climate risk (CI)	0.379	(0.391)
Market	0.506	(0.237)
Size (SMB)	-0.215	(0.254)
Value (HML)	0.196	(0.143)
Profitability (RMW)	0.096	(0.141)
Investment (CMA)	-0.140	(0.336)
Momentum (Mom)	0.007	(0.002)



# Conclusion

- ① Using NLP, we build greenwashing indices and show that greenwashing has become more important since 2018.
- ② Greenwashing concerns in the financial sector have been driving these indices since 2018.
- ③ Focus should be on improving disclosure and emissions measurement.
- ④ Greenwashing commands a positive risk premium.

# Intelligence artificielle pour la finance durable : réalités et défis

IA, données alternatives et ESG: perspectives académiques

**Serge Darolles** (Université Paris Dauphine-PSL) et  
**Anouck Faverjon** (HEC Liège, Université Paris Dauphine-PSL)  
aborderont le sujet :

*Deep learning, recommandations des analystes et ratings ESG*



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# Deep learning, recommandations des analystes et ratings ESG

Serge Darolles<sup>a</sup>

Anouck Faverjon<sup>a,b</sup>

Marie Lambert<sup>b</sup>

a



b

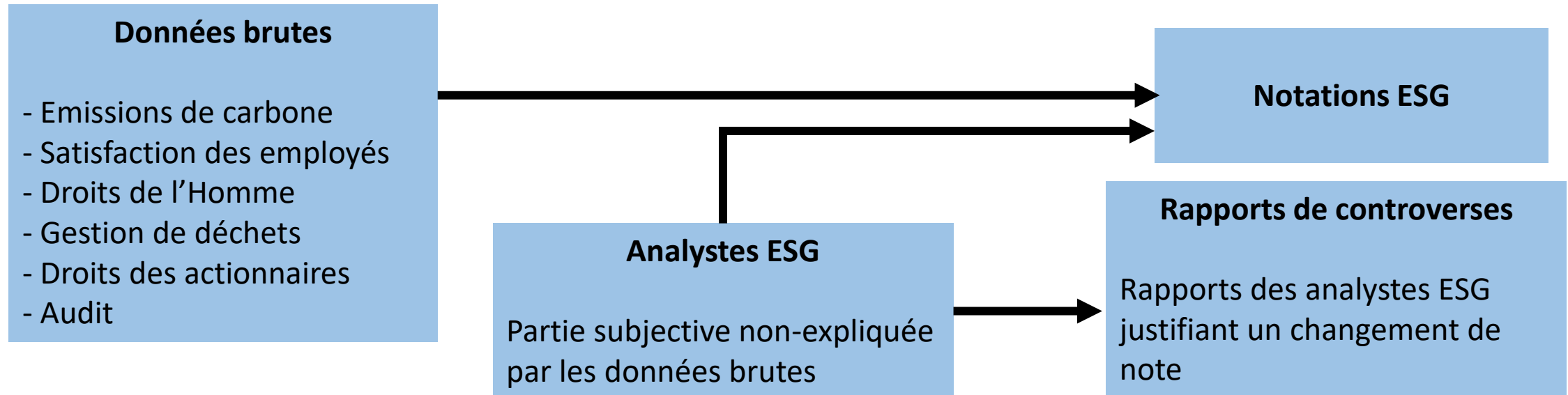


17 octobre 2023

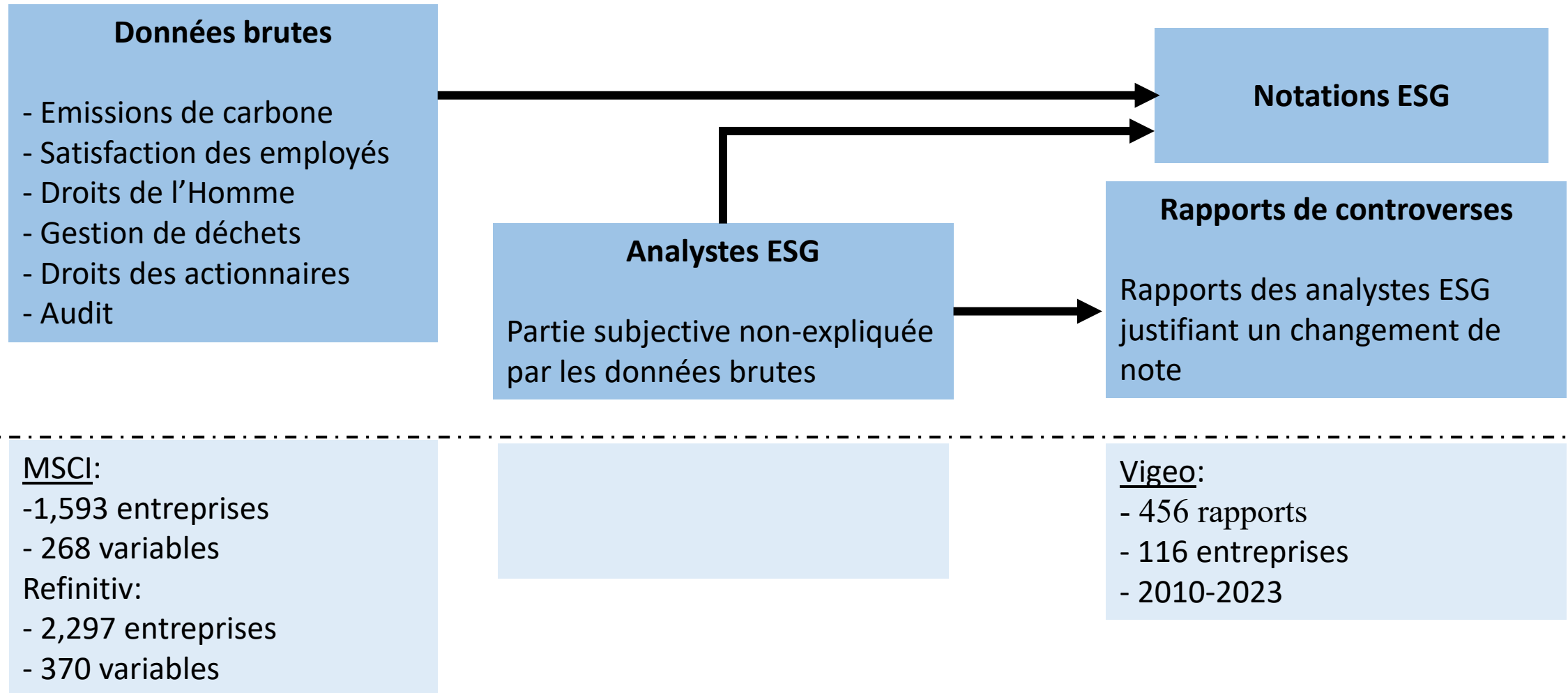
# Sommaire

- 1. Quelques perspectives sur les notations ESG**
2. Analyse financière et données ESG
3. Impact de l'acquisition par une institution financière
4. Conclusion

# Quelques perspectives sur les notations ESG



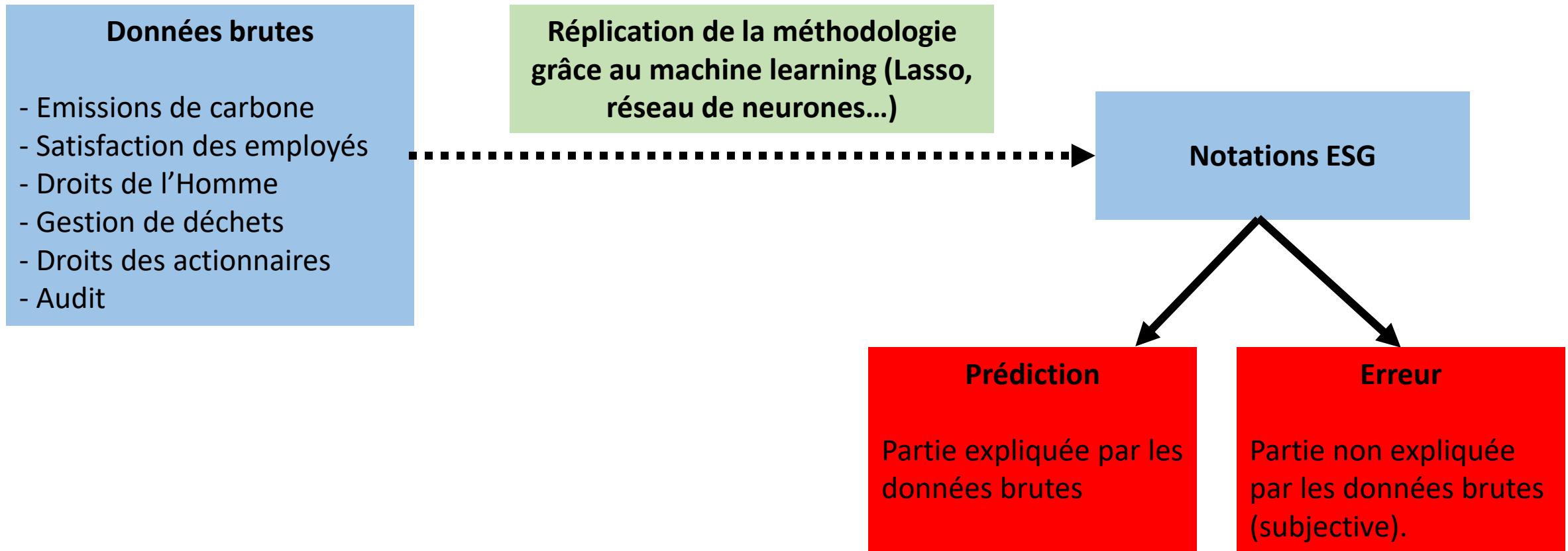
# Quelques perspectives sur les notations ESG



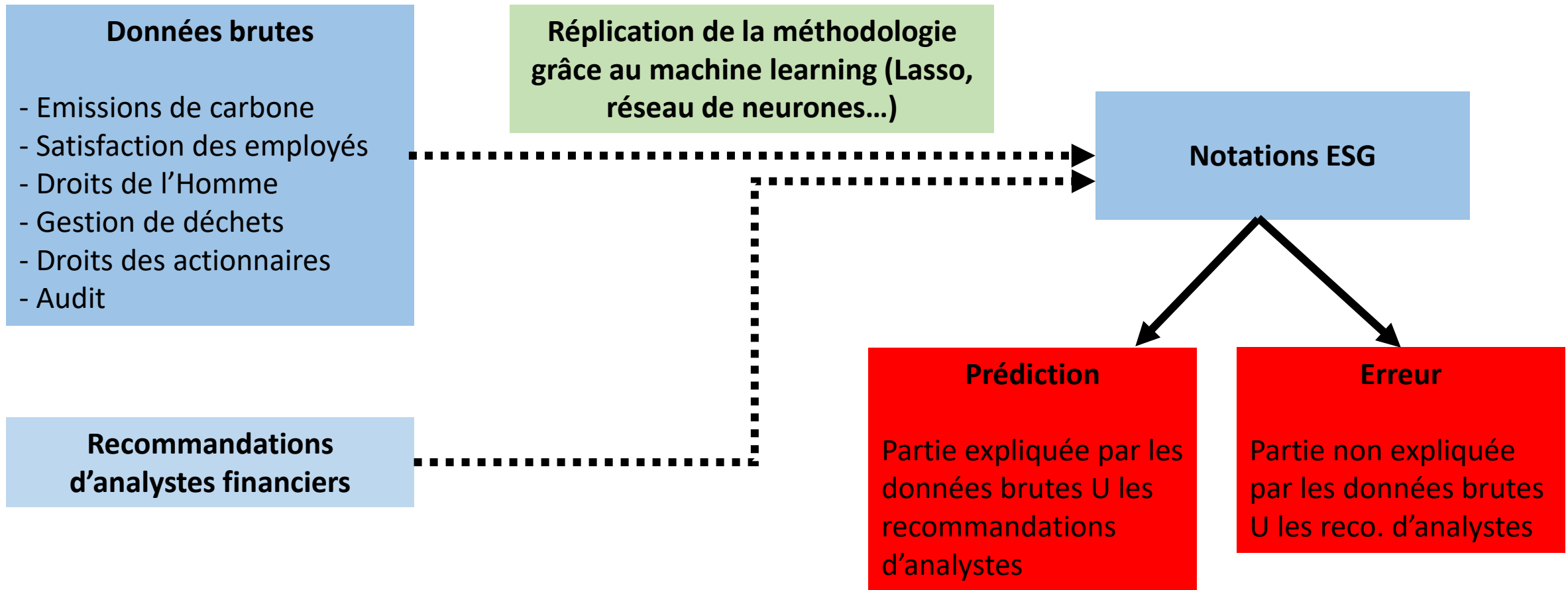
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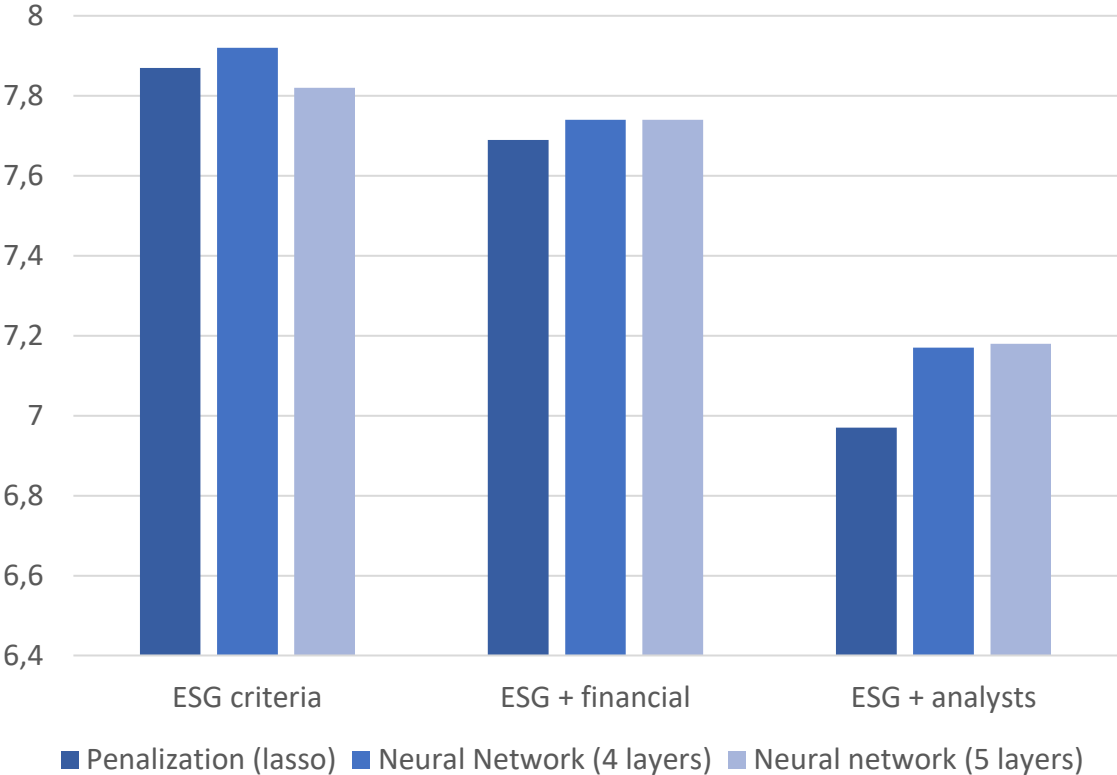
# Intégration de l'analyse financière dans les notations ESG



# Intégration de l'analyse financière dans les notations ESG

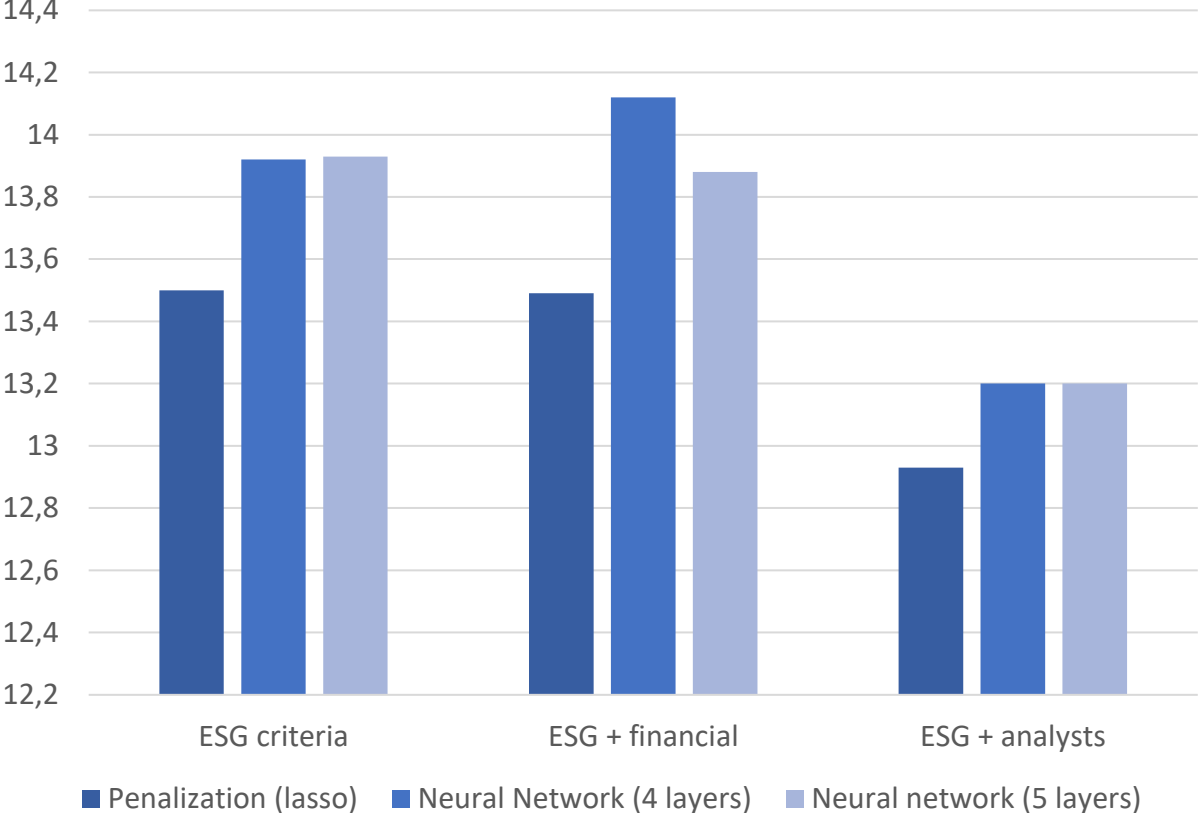


# Integration de l'analyse financière dans les notations ESG



MSCI

17 octobre 2023



Refinitiv

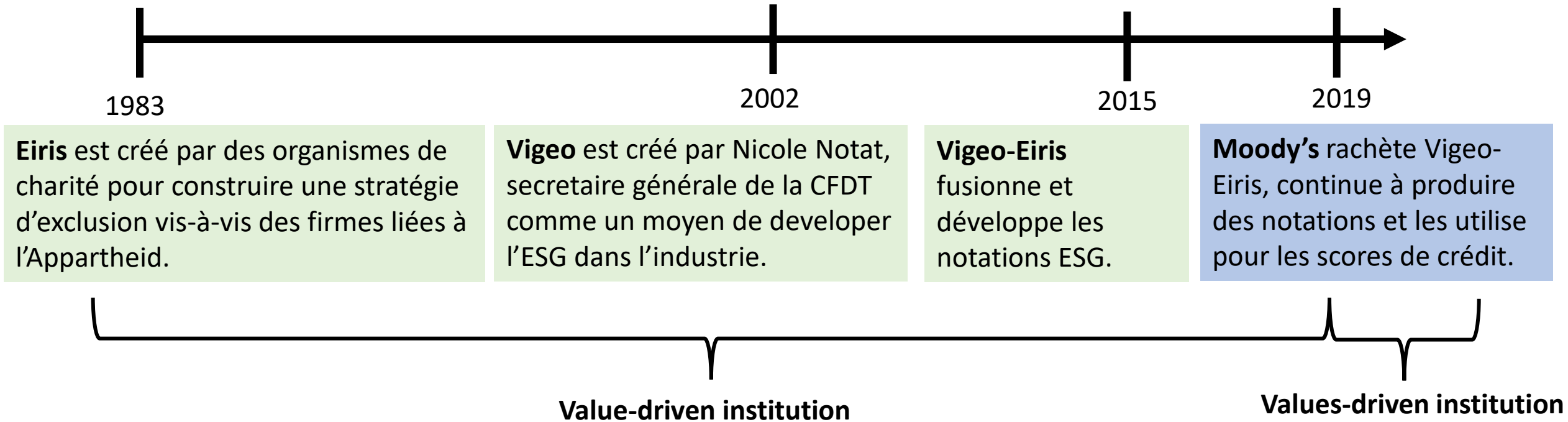


# Sommaire

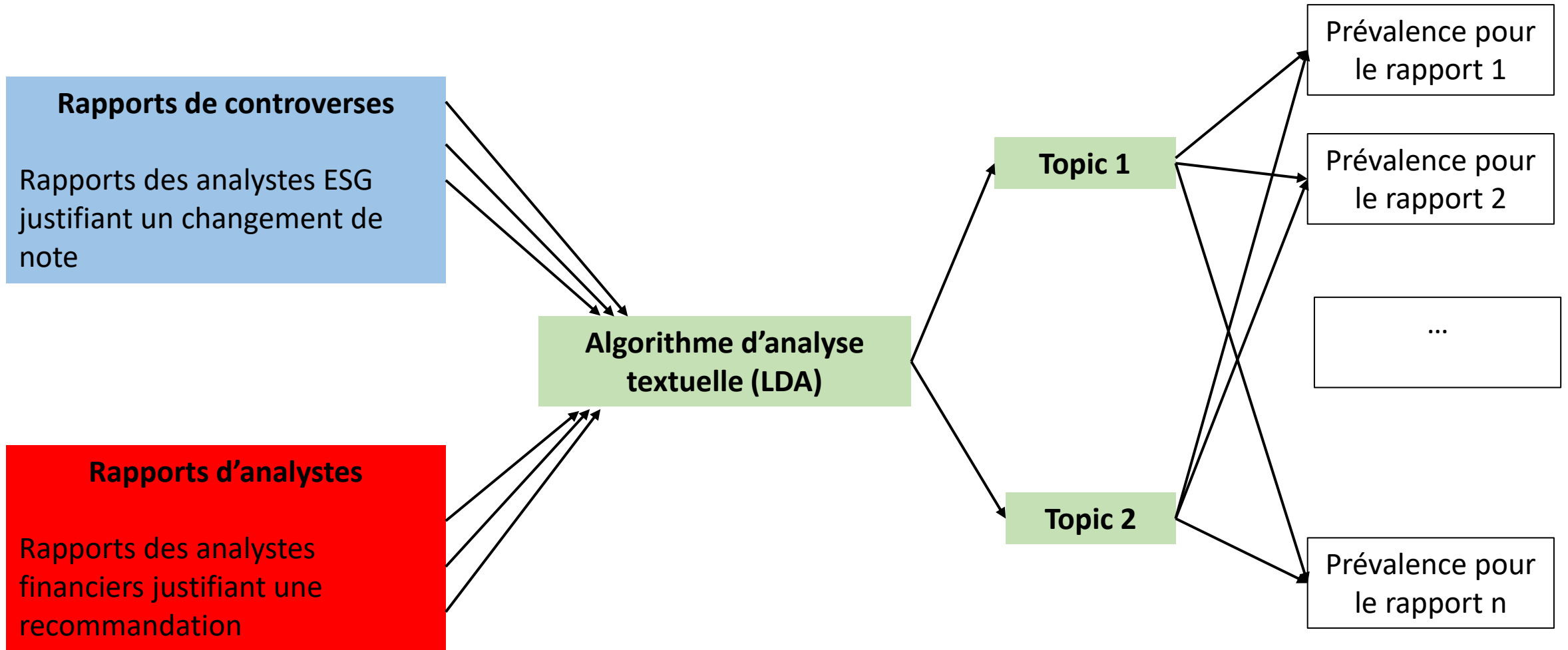
1. Quelques perspectives sur les notations ESG
2. Analyse financière et données ESG
- 3. Impact de l'acquisition par une institution financière**
4. Conclusion

# Un lien entre analyse financière et analyse ESG

« Nous avons conscience du besoin de faire évoluer notre métier et nous avons été sollicités par Moody's, raconte la fondatrice. Pour nos clients, il n'y aura aucun changement : Moody's continue son activité et nous la nôtre, mais la notation financière pourra désormais s'appuyer sur notre évaluation pour être affinée ».



# Impact de l'acquisition par une institution financière



# Impact de l'acquisition par une institution financière

## Topics Définis grâce au LDA sur les rapports ESG et financiers

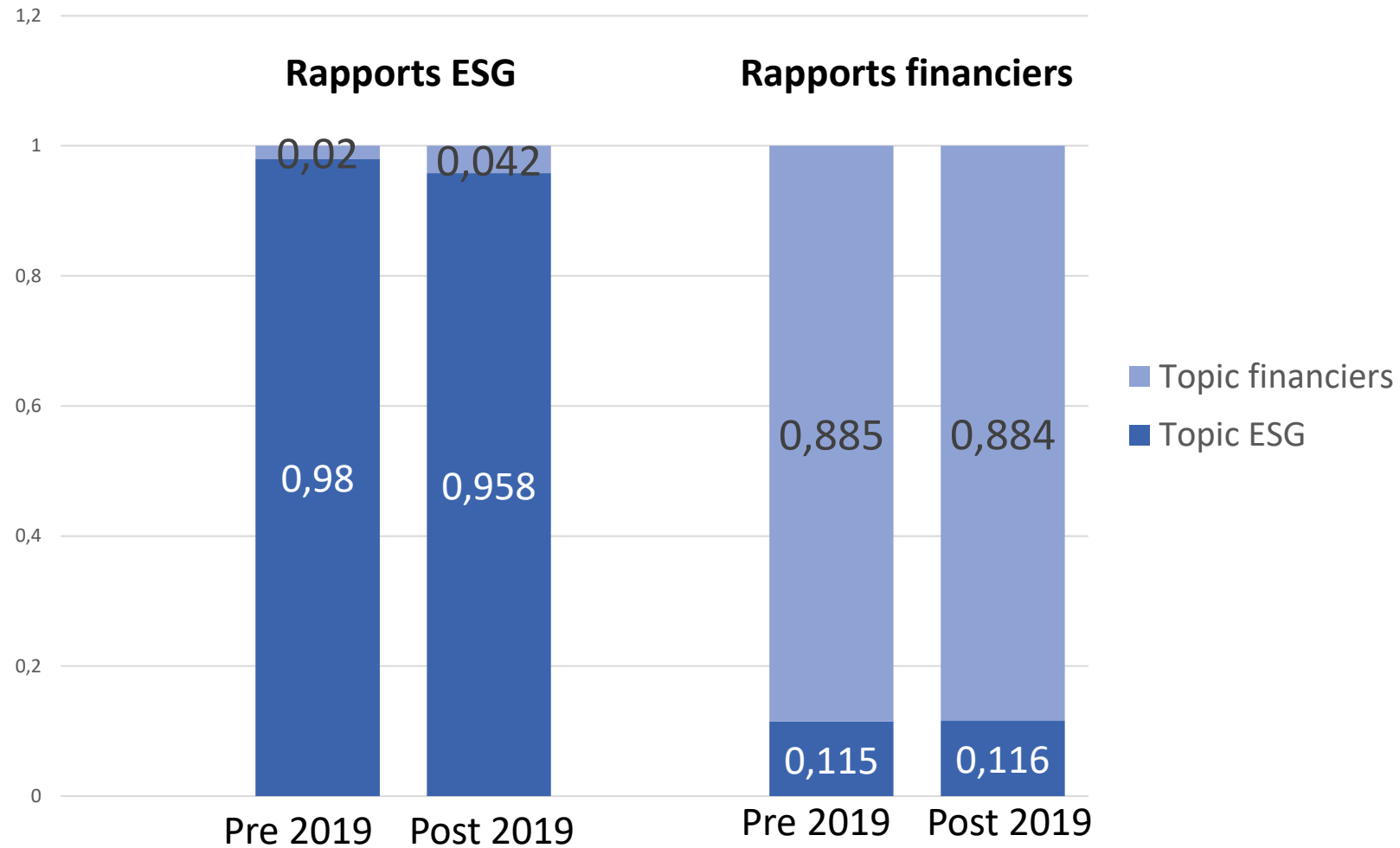
Topic 1: Topic financier

shares outlook  
net guide given reported  
target estimates consensus price  
prior estimate earnings revenue  
operating sales quarter year beat ahead  
mm strong jpme fcf guidance expect  
ebitda share growth line street model  
expected term eps margin market  
believe vs higher lower cash think  
management expectations

Topic 2: Topic ESG

event  
following rating reputation  
practices related north review products  
anti business measures safety impact  
customers company case allegations  
ability sustainability driver internal legal  
addition risks domain performance ensure  
monitor score limited commitment  
reported human rights opinion  
health employees remains information prevention  
product behaviour

# Impact de l'acquisition par une institution financière



# Conclusion



The screenshot shows the top navigation bar of the European Commission website. It includes the European Commission logo, a language selector set to 'English', and a search icon. Below the navigation bar is a blue header with the word 'Finance' and a 'Menu' icon. The breadcrumb trail reads: 'Home > Regulation, Supervision > Consultations > Targeted consultation on the functioning of the ESG ratings market'. The main heading of the page is 'Targeted consultation on the functioning of the ESG ratings market in the European Union and on the consideration of ESG factors in credit ratings'. Below this, there is a section titled 'About this consultation' with a sub-section 'Consultation period' indicating the dates '4 April 2022 - 10 June 2022 (midnight Brussels time)'.

## Points importants

- Les notations ESG intègrent de l'analyse financière.
- Cela est dû au rapprochement entre les agences de notations ESG et agences produisant de l'information financière.

## Implications

- Nécessité de réguler les liens entre notation financière et extra-financière.
- Nécessité de comprendre la logique sous-jacente aux scores ESG.

# Intelligence artificielle pour la finance durable : réalités et défis

IA et ESG: les applications en gestion d'actifs

Bruno Taillardat (AMUNDI) modère la table ronde avec :  
Luc Dumontier (OSSIAM)  
Raul Leote de Carvahlo (BNPPAM)  
Marine Neyret (Institut Louis Bachelier)  
Thierry Roncalli (AMUNDI)



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ossiam

# ESG Machine Learning

Luc Dumontier  
Head of Investments and Operations

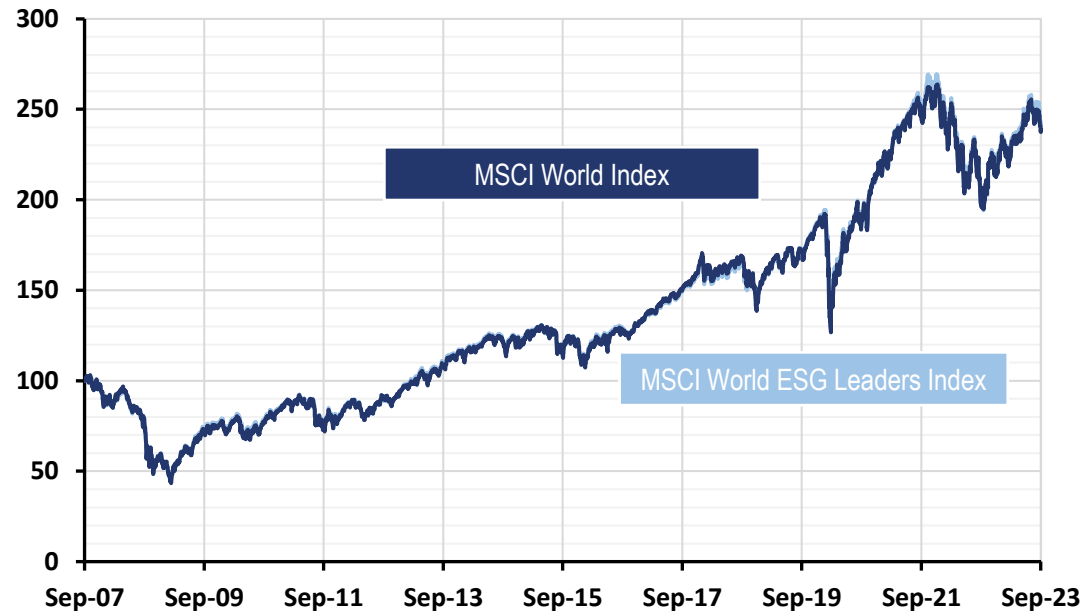
October 16<sup>th</sup> 2023



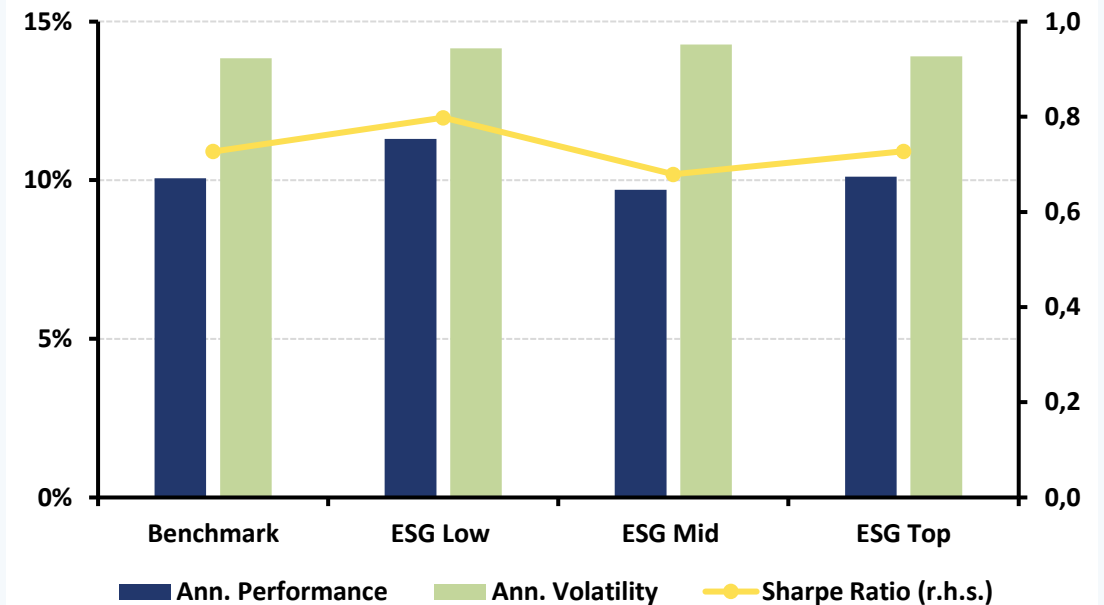
# No clear consensus on the ability of ESG integration to deliver higher returns

— 33 — Past performance does not predict future returns.

MSCI World Index vs MSCI World ESG Leaders Index  
Performance comparison from 28/09/2007 to 29/09/2023 <sup>(1)</sup>



Annualized performances, volatilities and Sharpe ratios for the benchmark and three portfolios sorted by ESG ratings <sup>(2)</sup>



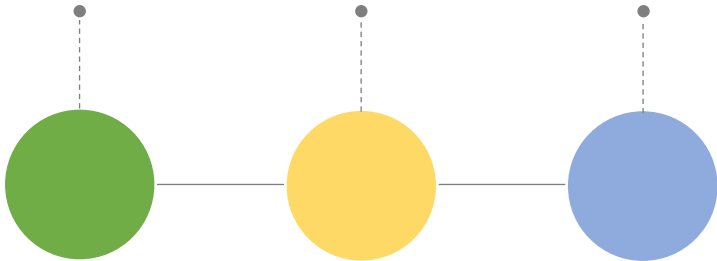
(1) Source: Bloomberg – Calculations by Ossiam in USD.

(2) C. De Franco, C. Geissler, V. Margot, and B. Monnier (2020) ESG investments: Filtering vs. machine learning approaches. Applied Economics and Finance 8 (2), 1-16. As of January 31, 2023.

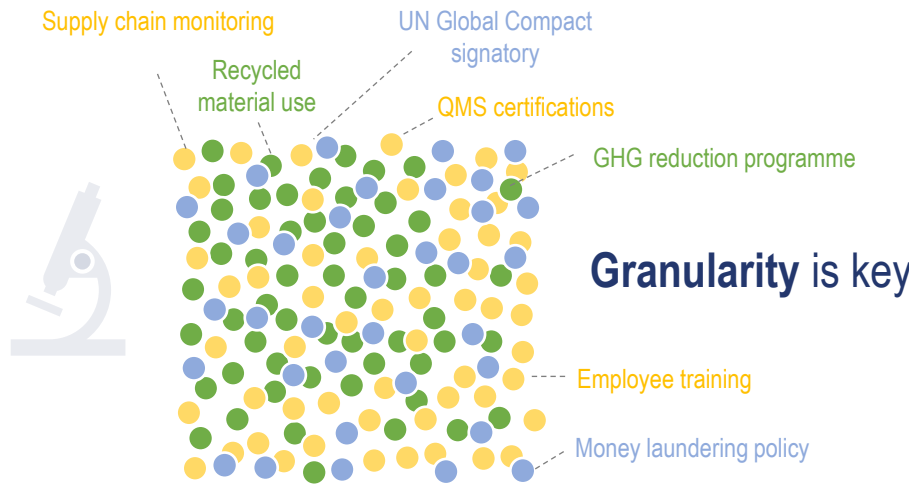
# Standard ESG ratings and loss of information



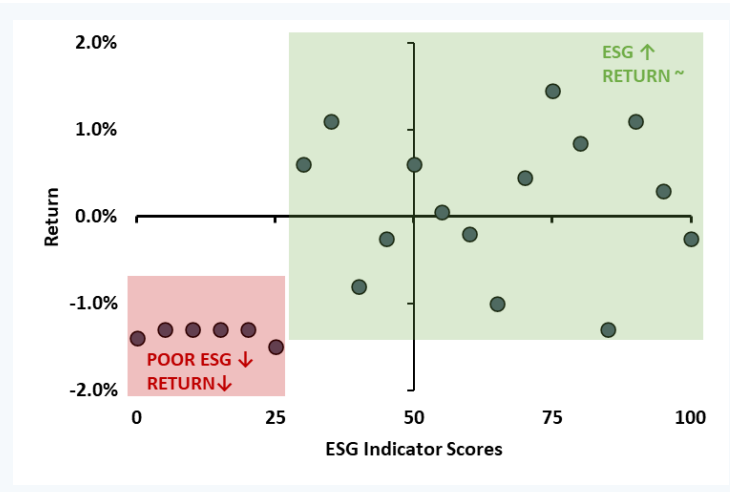
ENVIRONMENT SOCIAL GOVERNANCE



The **aggregated nature** of ESG ratings leads to a **loss of valuable information** contained in the ESG indicators



**Granularity is key**



**Non-linear relationship**

# Dataset for Ossiam's machine learning algorithm

## ESG data



ENVIRONMENT

56 indicators



SOCIAL

56 indicators



GOVERNANCE

34 indicators

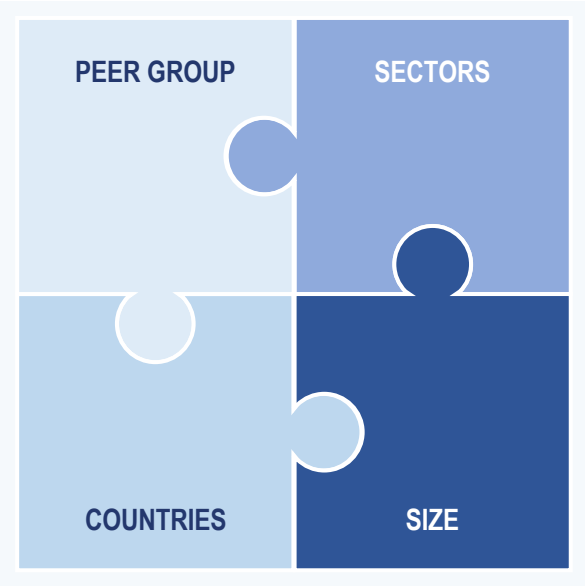


INCIDENTS

10 indicators

Approx. 150 granular ESG scores  
(from ESG data provider Sustainalytics)

## Classification



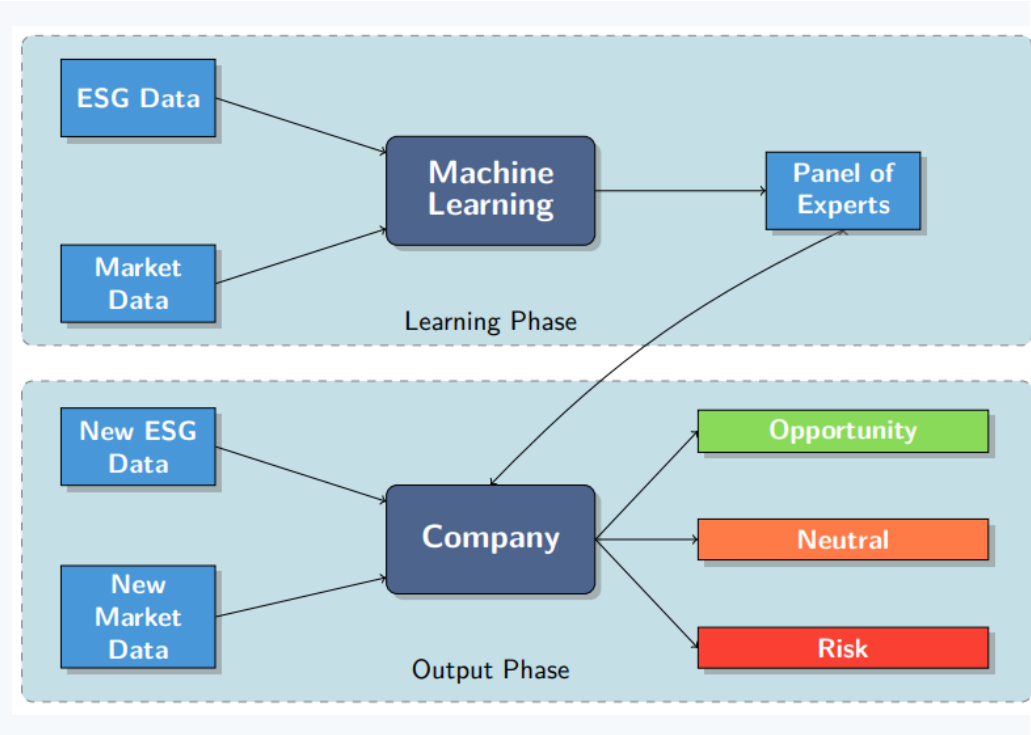
Approx. 600 relative ESG scores  
(vs country, vs sector, vs peer group...)

## Market data



# Learning process of the machine learning algorithm

Schematic diagram of the machine learning algorithm



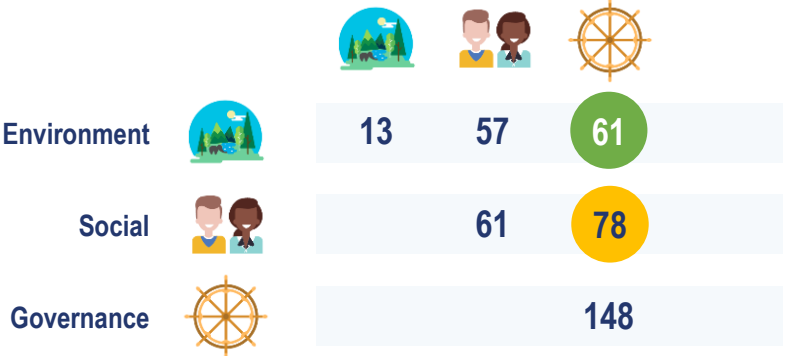
Every quarter, a new set of experts is calibrated using the previous quarter's set of experts...



... together with the latest quarterly ESG and market data over the past 4 years.

# Breakdown and examples of experts

## Breakdown of experts per ESG pillar



**More than 400 rules on ~70 indicators**

Close to 50% of rules are combining indicators from different pillars

## Examples

Example 1



Example 2



# Simulations

## Historical portfolio levels for the benchmark, the positive ESG ML Selection and the negative ML Selection



	Solactive GBS World Developed Market Large & Mid Index	Positive WDESGML	Negative WDESGML
<b>Performance</b>	9.4%	10.9%	6.8%
<b>Volatility</b>	14.5%	15.9%	13.9%
<b>Sharpe Ratio</b>	0.65	0.69	0.49
<b>Max. Drawdown</b>	-33.9%	-32.6%	-35.3%
<b>2013</b>	18.3%	20.0%	14.9%
<b>2014</b>	5.2%	14.5%	-5.2%
<b>2015</b>	-0.9%	2.1%	-2.6%
<b>2016</b>	7.6%	5.8%	8.5%
<b>2017</b>	22.4%	22.6%	20.0%
<b>2018</b>	-8.7%	-8.1%	-10.8%
<b>2019</b>	27.7%	30.5%	24.3%
<b>2020</b>	15.7%	19.7%	9.2%
<b>2021</b>	21.8%	19.9%	22.8%
<b>2022</b>	-18.3%	-22.0%	-15.7%
<b>2023</b>	16.2%	19.9%	14.4%

Source: MSCI/Datastream/Trucost/Sustainalytics/Bloomberg. Calculation by Ossiam in USD. The performance data represents the performance of the model portfolio developed based on the described algorithm and does not reflect the performance of an investment vehicle. Data based on a backtest. **Any data on past performance, modelling or back-testing contained herein does not predict future returns.** Backtested performance results do not represent the performance of actual trading using client assets, but are achieved by means of the retroactive application of a model. Backtested performance suffers from several limitations, namely they are constructed based on hindsight, and material economic and market factors, as well as client will, may have affected investment decisions differently without such hindsight. Additionally, they do not reflect the impact of actual portfolio trading, which could have affected the price and availability of securities, as well as the transaction fees paid. This model assumes reinvestment of net dividends and does not include any charges. Please note that if the performance of a strategy is calculated in a currency different from the currency of your area, any losses or gains generated by the strategy may be affected by exchange rate fluctuations (both upward and downward).

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**Sustainability risk** :The strategy is subject to sustainability risks as defined in the Regulation 2019/2088 (article 2(22)) by environmental, social or governance event or condition that, if it occurs, could cause an actual or a potential material negative impact on the value of the investment. More information on the framework related to the incorporation of Sustainability can be found on the website of the Investment Manager.

The Reference Index does not intend to be consistent with the environmental or social characteristics promoted by the strategy.

This product promotes environmental or social characteristics but does not have as its objective a sustainable investment. It might invest partially in assets that have a sustainable objective, for instance qualified as sustainable according to the EU classification.

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# Should Asset Managers estimate ESG data?

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- **Lack of reported and audited data**
  - The need for estimated data
- **Who should estimate ESG data?**
  - Data vendors
  - Asset managers
- **Lack of incentive for asset managers?**
  - Asset managers can produce better proprietary data estimates than data vendors **but**
  - Their clients use data estimates from data vendors for peer comparing and reporting

**Discrepancy of estimates can lead to asset managers investing in companies that rank poorly in vendors databases**

# Can AI estimate non-reported ESG data?

## AI can help capturing the systematic component of missing ESG data

- Example: predicting non-reported company carbon emissions
  - Extremely Randomized Trees
    - Regional
      - Carbon intensity of energy mix
      - Country carbon emission per GDP
      - ...
    - Sectors
      - Sector definition and levels
    - Energy
      - Consumption
      - Production
    - Company
      - Revenues
      - Number of employees
      - Capex
      - ...

*The Journal of Impact and ESG Investing*, Winter 2022, 3 (2) 36-54

DOI: <https://doi.org/10.3905/jesg.2022.1.059>

*Sustainability*, 2023, 15(4), 3391

DOI: <https://doi.org/10.3390/su15043391>

**Corporate Carbon Footprint: A Machine Learning Predictive Model for Unreported Data**

Thibaut Heurtebize, Frederic Chen, François Soupé, and Raul Leote de Carvalho

**KEY FINDINGS**

■ We address the question of how to predict carbon emissions for companies that have

**Greenhouse Gases Emissions: Estimating Corporate Non-Reported Emissions Using Interpretable Machine Learning**

by Jérémie Assael<sup>1,2,\*</sup>, Thibaut Heurtebize<sup>3</sup>, Laurent Carlier<sup>2</sup> and François Soupé<sup>3</sup>

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**Abstract**

As of 2022, greenhouse gases (GHG) emissions reporting and auditing are not yet compulsory for all companies, and methodologies of measurement and estimation are not unified. We propose a machine learning-based model to estimate scope 1 and scope 2 GHG emissions of companies not reporting them yet. Our model, designed to be transparent and completely adapted to this use case, is able to estimate emissions for a large universe of companies. It shows good out-of-sample global performances as well as good out-of-sample granular performances when evaluating it by sectors, countries, or revenue buckets. We also compare the model results to those of other providers and find our estimates to be more accurate. Explainability tools based on Shapley values allow the constructed model to be fully interpretable, the user being able to understand which factors split explains the GHG emissions for each particular company.

**Keywords:** sustainability; disclosure; greenhouse gas emissions; machine learning; interpretability; carbon emissions; scope 1; scope 2

**JEL Classification:** C51; C52; C55; G17; G18; Q51; Q52; Q54

# Can AI mis-lead when estimating ESG data?

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- **Example of estimating ESG controversies from news using NLP**
  - Due diligence uncovered problems in the data of some vendors
    - News volume decays exponentially with market cap
      - More than one news article a day for mega caps
      - Hardly any news for small caps
    - Mis-classification of news in topics
      - News about same issue not always classified in same topic
    - Problem of speculative news
      - Sometimes there is smoke without fire
    - Problem of fake news
      - No easy fact check
      - Even reliable news providers can fail

**No human in the loop can be an issue**

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# L'IA AU SERVICE D'UNE FINANCE DURABLE

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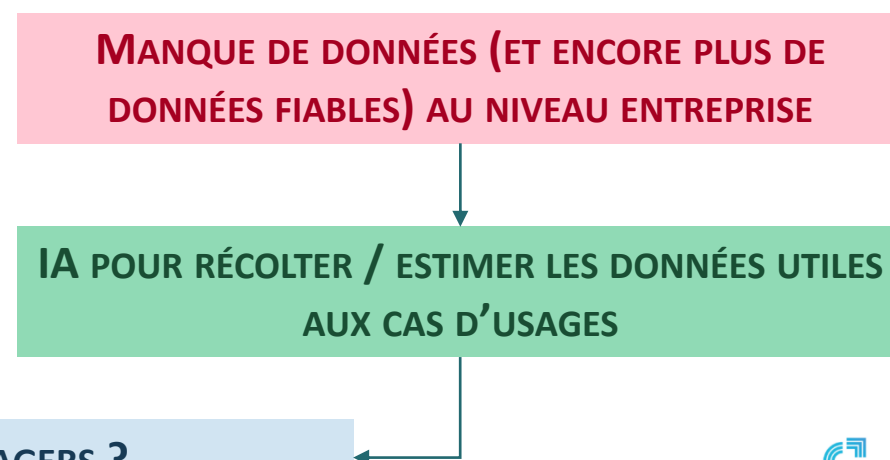
# UNE CELLULE DE R&D AYANT TRAVAILLÉ SUR PLUSIEERS CAS D'USAGE CONCRETS AFIN D'EXPLOITER L'INTELLIGENCE ARTIFICIELLE AU SERVICE D'UNE FINANCE DURABLE



## MÉTHODE DE TRAVAIL DES ILB LABS



## CAS DES PROJETS IA & FINANCE DURABLE



QUELLES DONNÉES ET QUELS CAS D'USAGE POUR LES ASSET MANAGERS ?



# RÉCUPÉRATIONS D'INFORMATIONS GRANULAIRES IDENTIFIANT LES ENTREPRISES NON COMPATIBLES AVEC LES POLITIQUES D'EXCLUSION ADOPTÉES PAR L'INVESTISSEUR

## ASSET MANAGER

POLITIQUES  
D'EXCLUSION



Réduction du champ  
d'investissement

Vérifier que les investissements sont en  
conformité avec les stratégies choisies

*Ex : est-ce que l'entreprise souhaite se développer ou investir dans le charbon ? Le tabac ? Le gaz de schiste ...*

## APPROCHE

### Annotation

Sélection de phrases des RA & Génération avec ChatGPT

### Apprentissage

Modèle NLP pré-entraîné & Fine-tuning en Few Shot Learning\*

### Explicabilité

Identification des mots les plus importants pour la classification

### Analyse

Mise en avant des phrases à analyser par un.e expert.e

## DONNÉES UTILISABLES

Entr. : **Corpus de textes variés** → **Phrases à analyser**

### RISQUES ET BIAIS

Si thématique trop peu abordée : complexité à avoir un modèle robuste



- Utilisation des résultats (ex : score agrégé) dans le **reporting des PAI** dans le cadre de SFDR (article 9)
- Duplicable pour évaluer le **positionnement des entreprises sur toute thématique ESG** (ex : implication pour le droit des salariés), **anticiper les controverses** ou **rechercher l'exposition à certains risques** (réputation, transition, climatique)...

INSTITUT  
Louis Bachelier

DATA LAB

\*Few Shot Learning : méthode d'apprentissage nécessitant peu de données labélisées pour généraliser

AFG  
Ensemble, s'investir pour demain

Fa  
IR

# QUELLE EST L'EXPOSITION SECTORIELLE RÉELLE DE L'ACTIVITÉ D'UNE ENTREPRISE ?

## ASSET MANAGER

Demande croissante  
des investisseurs



PORTEFEUILLE  
NET ZERO

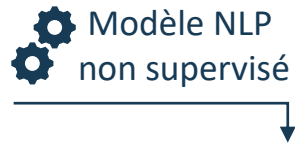
Connaitre l'exposition de ses  
investissements aux secteurs d'activités

*Ex : est-ce que, pour General Electric, nous pourrions avoir mieux que « Conglomérat Industriel » sachant ses multiples activités dans la finance, le médical, l'aviation... ?*

## APPROCHE



Description  
code NACE



Phrase provenant  
des rapports  
financiers

Embedding\*

Calcul de  
similarité

Identification des  
phrases les plus  
représentatives de  
chaque NACE

## DONNÉES UTILISABLES

Entr. :

Rapport  
d'activité



Exposition  
aux NACE

### RISQUES ET BIAIS

Représentativité erronée si emphase importante sur des secteurs marginaux



- Affinement de l'alignement des portefeuilles en utilisant des scénarios multi-sectoriels pour une entreprise selon son activité réelle : décarboner en ayant une économie robuste

aujourd'hui : en attendant l'obligation de la CSRD pour l'Europe, demain : pour utilisation sur le reste du monde, CSRD permettra la création d'un score en supervisé

Louis Bachelier

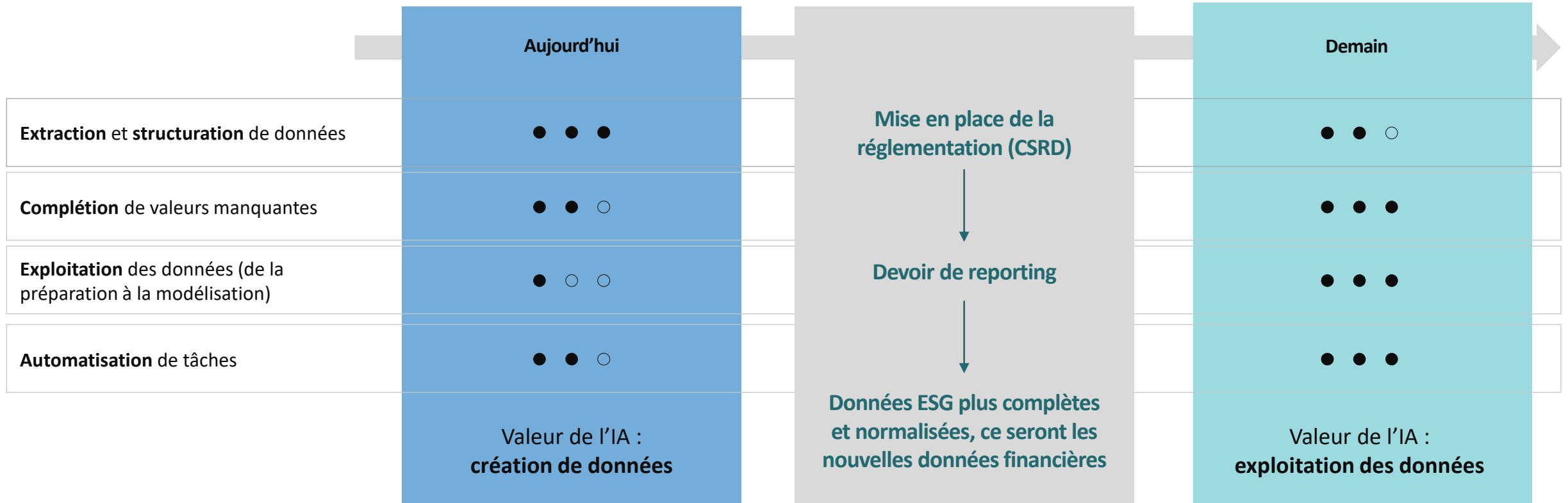
DATA LAB

\*Embedding : représentation numérique d'une phrase



Fa  
IR

# CONCLUSION : COMMENT EXPLOITER L'INTELLIGENCE ARTIFICIELLE ?



# AI, Machine Learning & ESG

## Quant Portfolio Strategy\*

\*Amundi Investment Institute, Amundi Asset Management<sup>1</sup>, France

AFG, 17 October 2023, Paris

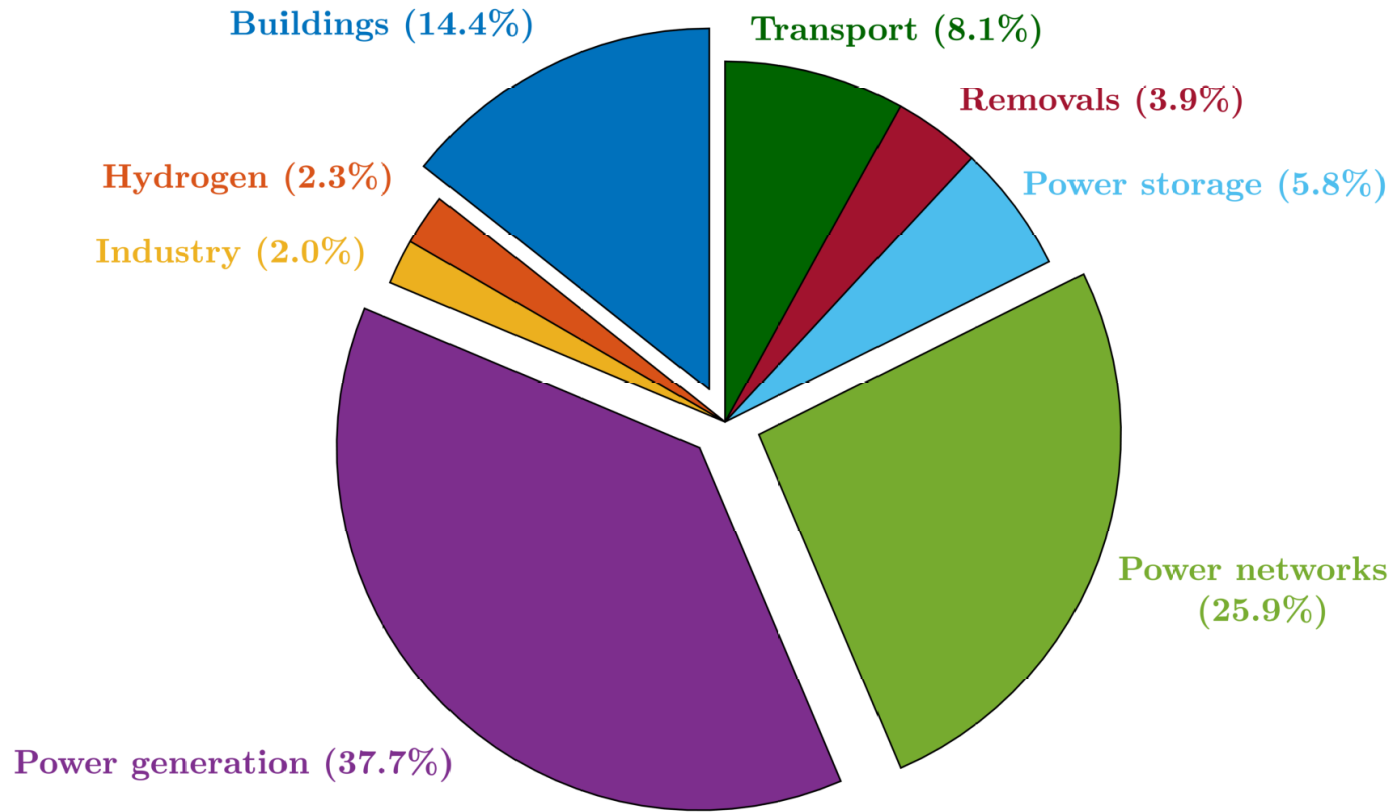


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<sup>1</sup>The opinions expressed in this presentation are those of the authors and are not meant to represent the opinions or official positions of Amundi Asset Management.

# The Financing Issue of Net Zero

Figure: Net zero capital investments



Source: Energy Transitions Commission (2023a, page 6) & Authors' calculations.

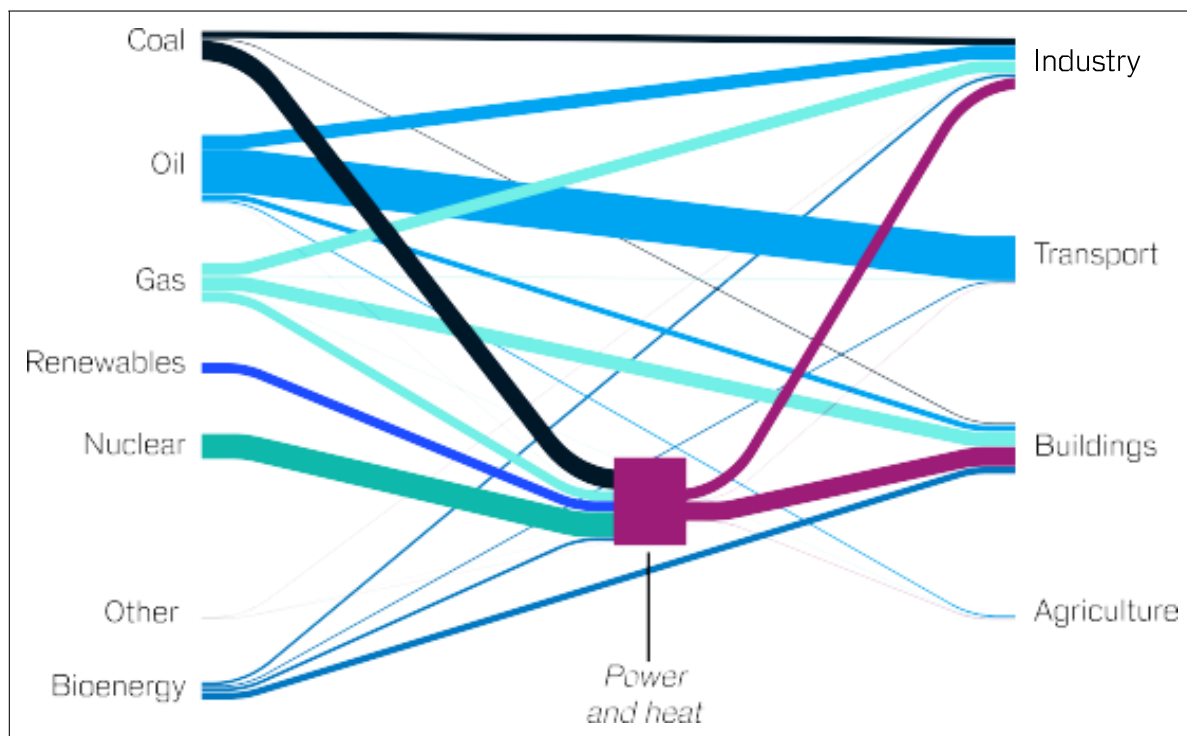
*“The transition to net-zero greenhouse emissions by 2050 will require an extra **\$3.5 trillion a year** in capital spending on physical assets for energy and land-use systems” (McKinsey, 2022)*

## Some examples

- 27000 TWh  $\Rightarrow$  130000 TWh in 2050
- 70 million km  $\Rightarrow$  200 million km in 2050
- Green hydrogen: 500 – 800 Mt/year vs 1 Mt/year today

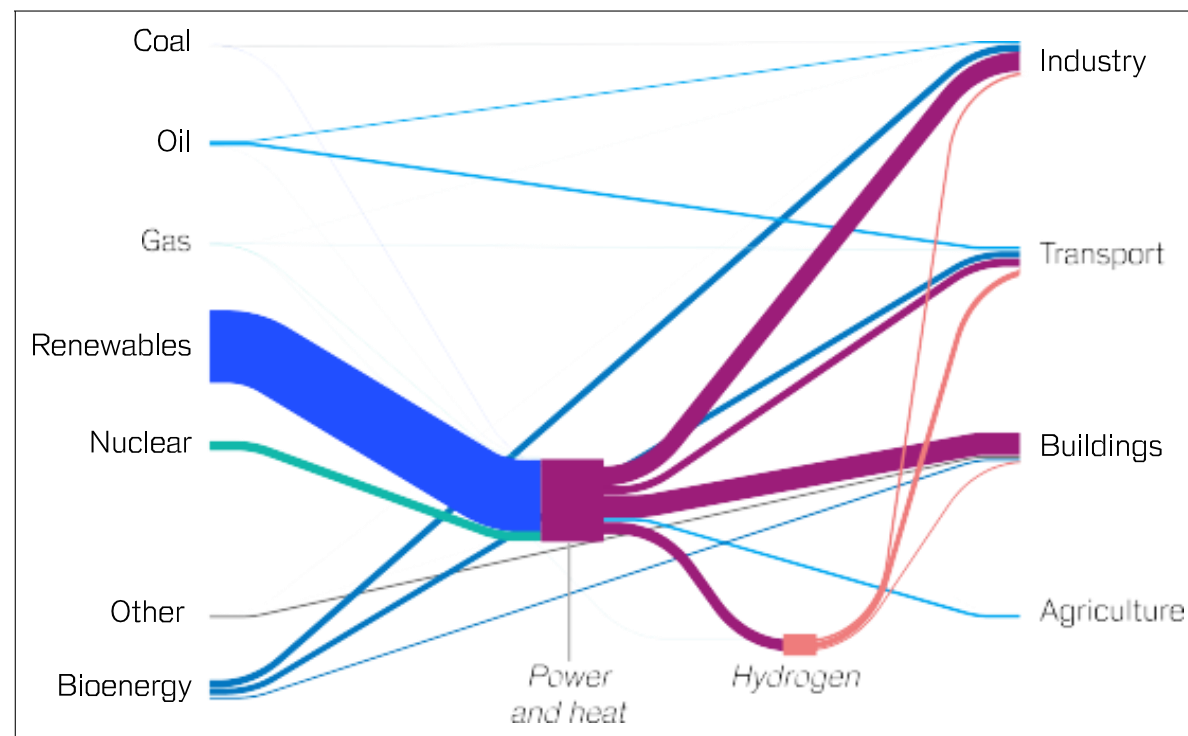
# Transforming the Global Value Chain into a Net Zero Economy

Figure: 2017



Source: McKinsey (2023, Exhibit 6B, page 12).

Figure: 2050



Source: McKinsey (2023, Exhibit 6B, page 12).

# How to Screen Net Zero Technology?

Table: Net zero mineral requirements (IEA, 2022)

	Cu	Co	Ni	Li	REEs	Cr	Zi	PGMs	Al
Solar PV	●	○	○	○	○	○	○	○	●
Wind	●	○	●	○	●	●	●	○	●
Hydro	●	○	○	○	○	●	●	○	●
CSP	●	○	●	○	○	●	●	○	●
Bioenergy	●	○	○	○	○	○	●	○	●
Geothermal	○	○	●	○	○	●	○	○	○
Nuclear	●	○	●	○	○	●	○	○	○
Elect Net	●	○	○	○	○	○	○	○	●
EVs/BS	●	●	●	●	●	○	○	○	●
Hydrogen	○	○	●	○	●	○	○	●	●

● = high, ● = moderate, ○ = low

## Results

Reader	Prec.	Recall	F1	Exec.
RoBERTa*	76%	80%	78%	98' 27"
Electra**	74%	70%	72%	144' 06"
XLNet***	76%	65%	70%	146' 54"
ALBERT****	83%	95%	88%	369' 44"

\* roberta-base-SQuAD2

\*\* electra-large-discriminator-SQuAD2-512

\*\*\* xlm-roberta-large-SQuAD2

\*\*\*\* albert-xxlargev1-SQuAD2-512

Source: Amundi Investment Institute (2023).

Table: Question-Answering Large Language Model

	Cu	Co	Ni	Li	REEs	Cr	Zi	PGMs	Al
Solar PV	●	○	○	○	○	○	○	○	●
Wind	●	○	○	○	●	○	●	○	○
Hydro	○	○	○	○	○	○	○	○	○
CSP	●	○	○	○	○	○	○	○	●
Bioenergy	●	○	○	○	○	○	○	○	○
Geothermal	○	○	●	○	○	●	○	○	○
Nuclear	○	○	○	○	○	○	○	○	○
Elect Net	●	○	○	○	○	○	○	○	●
EVs/BS	●	●	●	●	●	○	●	○	●
Hydrogen	●	○	●	●	○	○	○	●	○

- AIBERT replicates 88% of the *IEA expert knowhow*
- RoBERTa is the better compromise
- Extension to Heavy Rare Earth Elements (Dy<sup>m</sup>, Er, Eu, Gd<sup>m</sup>, Ho, Lu, Tb<sup>m</sup>, Tm, Yb, Y) & Light Rare Earth Elements (Ce<sup>m</sup>, La, Nd<sup>m</sup>, Pr<sup>m</sup>, Sm<sup>m</sup>)

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# Intelligence artificielle pour la finance durable : réalités et défis

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