The Puzzle

- May 2022: Tesla removed from S&P 500 ESG Index
- Exxon remained in the index
- Tesla ESG score: 37 (S&P 2022)
- Shell ESG score: 41 (S&P 2022)
- Same company, different ratings across providers
- BMW rated 93rd percentile vs Tesla lower despite EV focus

Questions This Raises

- How can oil companies score higher than EV makers?
- Why do ESG ratings diverge so much?
- What drives rating methodology differences?
- Are ESG ratings measuring what investors think?
- Can you trust ESG scores for investment decisions?
- What explains 0.61 correlation vs 0.99 for credit ratings?

[Discovery 1] This puzzle will be resolved by Goal 1—rating methodologies and divergence

Learning Goal 1

Understand ESG Rating Methodologies and Data Landscape

theoretical — Foundation - Maps the ESG data ecosystem

The ESG Data Ecosystem

ESG Data Market Overview
- Global ESG data market exceeded $1B in 2021
- Top 5 providers control 65% of 2024 revenue
- Over $33.6 trillion in ESG-focused AUM globally
- Rapid consolidation through M&A activity
- Growing regulatory demand for ESG disclosure

Key Market Drivers
- Institutional investor mandates
- Regulatory requirements (SFDR, CSRD)
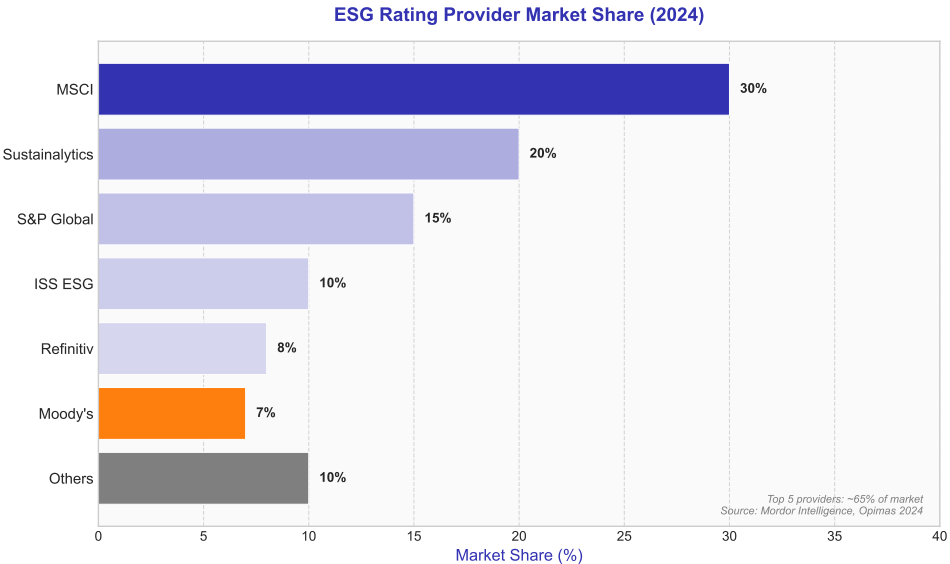- Corporate sustainability commitments

Data Sources
- Company self-reported disclosures
- Third-party data providers
- News and media analysis
- Regulatory filings
- Alternative data (satellite, NLP)

Data Quality Challenges
- Inconsistent reporting standards
- Self-reporting bias
- Coverage gaps in emerging markets
- Time lag in data updates

[Goal 1] ESG data ecosystem valued at $33.6T AUM with significant quality challenges

Major ESG Rating Providers

ESG Rating Provider Market Share (2024)

Provider	Market Share (%)
MSCI	30%
Sustainalytics	20%
S&P Global	15%
ISS ESG	10%
Refinitiv	8%
Moody's	7%
Others	10%

Top 5 providers: ~65% of market
Source: Mordor Intelligence, Opimas 2024

Market Share (%)

Provider Methodology Comparison

MSCI ESG Ratings

- Coverage: 8,500+ public companies
- Focus: Financial materiality
- Scale: AAA to CCC (7 levels)
- Key feature: Industry-adjusted scores
- 40% revenue growth in 2024

Sustainalytics (Morningstar)

- Coverage: 15,000+ companies
- Focus: ESG risk exposure
- Scale: 0-100 risk score
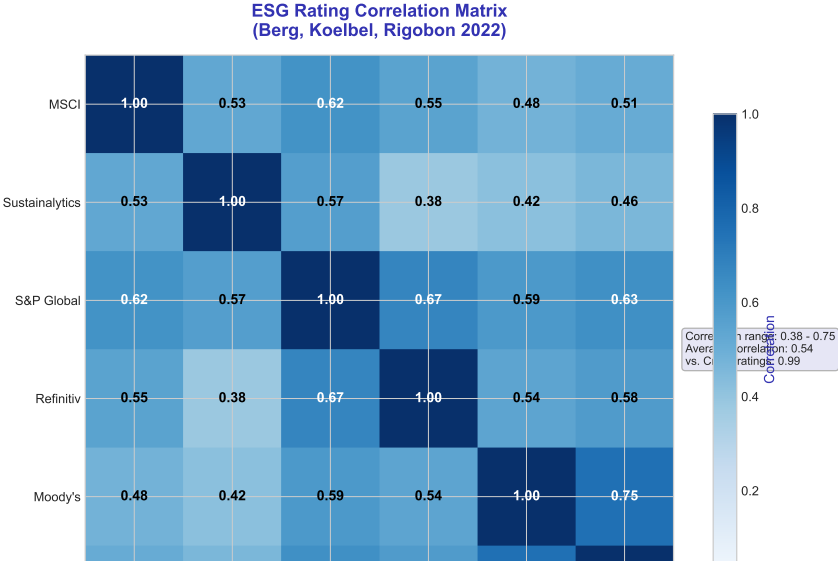- Key feature: Controversy monitoring

S&P Global ESG

- Coverage: 12,000+ issuers
- Focus: Stakeholder impact
- Scale: 0-100 score
- Key feature: Satellite environmental data

Refinitiv (LSEG)

- Coverage: 10,000+ companies
- Focus: Controversy-weighted
- Scale: 0-100 percentile
- Key feature: News sentiment integration

[Goal 1] Each provider uses distinct methodology, scope, and weighting schemes

The Rating Divergence Problem

ESG Rating Correlation Matrix
(Berg, Koelbel, Rigobon 2022)

	MSCI	Sustainalytics	S&P Global	Refinitiv	Moody's	
MSCI	1.00	0.53	0.62	0.55	0.48	0.51
Sustainalytics	0.53	1.00	0.57	0.38	0.42	0.46
S&P Global	0.62	0.57	1.00	0.67	0.59	0.63
Refinitiv	0.55	0.38	0.67	1.00	0.54	0.58
Moody's	0.48	0.42	0.59	0.54	1.00	0.75

Correlation range: 0.38 - 0.75
Average correlation: 0.54
vs. Credit ratings: 0.99

Berg, Koelbel, Rigobon (2022)
Study analyzed 6 major ESG rating agencies:

- KLD (Kinder, Lydenberg, Domini)
- Sustainalytics
- Moody's ESG (Vigeo-Eiris)
- S&P Global (RobecoSAM)
- Refinitiv (Asset4)
- MSCI

Key Finding

- Average correlation: 0.54
- Range: 0.04 to 0.75
- vs. Credit ratings: 0.99

Sources of Divergence

- **Measurement (56%):** Different indicators for same attribute
- **Scope (38%):** Different attributes measured
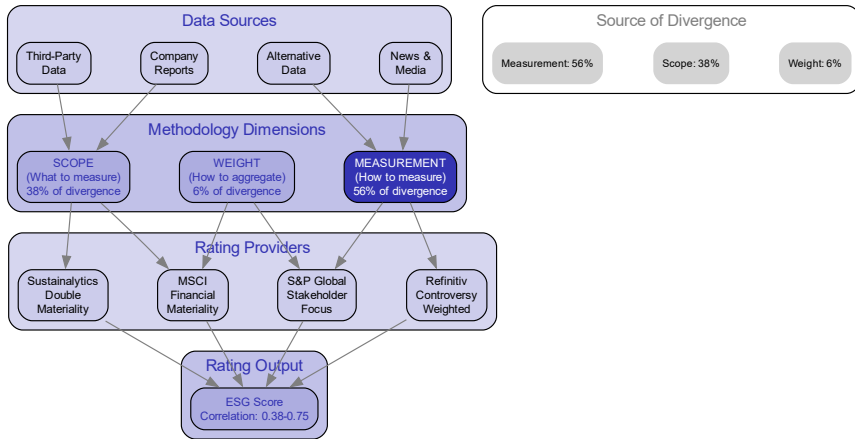- **Weight (6%):** Different aggregation schemes

Implications

- Measurement divergence hardest to resolve
- Weight adjustments provide limited benefit
- Rater effect: Overall view influences specifics
- Reduces incentives for ESG improvement

[Goal 1] Measurement divergence (56%) is the primary driver and most difficult to address

ESG Rating Methodology Comparison

Data Sources
- Third-Party Data
- Company Reports
- Alternative Data
- News & Media

Source of Divergence
- Measurement: 56%
- Scope: 38%
- Weight: 6%

Methodology Dimensions
- SCOPE (What to measure) 38% of divergence
- WEIGHT (How to aggregate) 6% of divergence
- MEASUREMENT (How to measure) 56% of divergence

Rating Providers
- Sustainalytics Double Materiality
- MSCI Financial Materiality
- S&P Global Stakeholder Focus
- Refinitiv Controversy Weighted

Rating Output
- ESG Score Correlation: 0.38-0.75

Case Study: Tesla Rating Divergence

Tesla's ESG Ratings (2024)
- MSCI: BBB (Average)
- Sustainalytics: 24.7 (Medium Risk)
- Refinitiv: 72/100
- S&P Global: Dropped from ESG Index

Why S&P Removed Tesla
- Lack of low-carbon strategy disclosure
- Insufficient business conduct codes
- Racial discrimination allegations
- Poor working conditions reports

Methodology Differences
- **MSCI:** Financial materiality focus
- **Sustainalytics:** Double materiality
- **S&P:** Stakeholder impact focus

Key Insight
Poor "S" (Social) rating can obscure positive "E" (Environmental) rating in aggregate scores.

Lesson for Investors
Single ESG score insufficient; pillar-level analysis required.

[Goal 1] Tesla demonstrates how methodology differences lead to contradictory conclusions

Emerging Alternative Data Sources

Satellite and Geospatial Data
- Methane emission monitoring
- Deforestation tracking
- Supply chain facility mapping
- Physical climate risk assessment
- Real-time environmental verification

Natural Language Processing
- News sentiment analysis
- Controversy detection
- Regulatory filing parsing
- Social media monitoring

Supply Chain Data
- Tier-1 and Tier-2 supplier mapping
- Modern slavery risk indicators
- Environmental compliance tracking
- Labor practice verification

Benefits of Alternative Data
- Reduces self-reporting bias
- Near real-time updates
- Harder to manipulate
- Expanded coverage

[Goal 1] Alternative data sources address key limitations of traditional self-reported ESG data

The Puzzle

- 2023: Worst year for US ESG funds on record
- $13 billion withdrawn from US sustainable funds
- Average Article 9 fund underperformed by 6.16%
- Article 8 funds underperformed by 0.84%
- H1 2024: $13B more in outflows
- Only 24.15% of ESG funds outperformed (Jul 2023-Jun 2024)

Questions This Raises

- Why did "greenest" funds perform worst?
- Does ESG integration hurt returns?
- Is the ESG investment case broken?
- What drives the performance gap?
- Can portfolio integration solve this?
- How do active vs passive ESG strategies differ?

[Discovery 2] This puzzle will be resolved by Goal 2—integration techniques and performance

Learning Goal 1: Summary

What We Achieved

- ✓ Mapped the ESG data ecosystem
- ✓ Compared major provider methodologies
- ✓ Understood rating divergence problem
- ✓ Analyzed divergence sources (Berg et al.)
- ✓ Examined Tesla as case study
- ✓ Explored alternative data sources

Can You Now...

- Explain why ESG ratings diverge across providers?
- Identify the three sources of divergence?
- Compare MSCI vs. Sustainalytics methodologies?
- Describe limitations of self-reported data?
- Evaluate when to use multiple ESG sources?

Key Takeaway: ESG rating divergence (avg correlation 0.54) requires multi-source analysis and pillar-level examination rather than reliance on single aggregate scores.

[Goal 1] Achieved - Now ready to apply this understanding to integration strategies

Learning Goal 2

Apply ESG Screening and Integration Strategies

quantitative — Build - Develops portfolio construction skills

ESG Integration Strategy Comparison

Negative/Exclusionary Screening

Definition
Removal of companies/sectors that contradict investor values or fail minimum standards.

Common Exclusions

- Tobacco and weapons manufacturers
- Thermal coal producers (¿25% revenue)
- Controversial weapons (cluster munitions)
- Companies violating UN Global Compact
- High carbon intensity firms

Adoption Rate: 10.4% of mutual funds

Implementation

- Define exclusion criteria
- Map securities against criteria
- Remove excluded securities
- Reallocate to remaining universe

Trade-offs

- + Clear values alignment
- + Easy to implement and communicate
- - Reduced diversification
- - Potential tracking error
- - Sector/region biases

[Goal 2] Negative screening is values-based but creates portfolio concentration risks

Definition

Selection of top ESG performers within each sector, maintaining industry diversification.

Implementation Steps

1. Segment universe by sector
2. Rank companies by ESG score
3. Select top performers (e.g., top 50%)
4. Weight by market cap or equal weight
5. Rebalance periodically

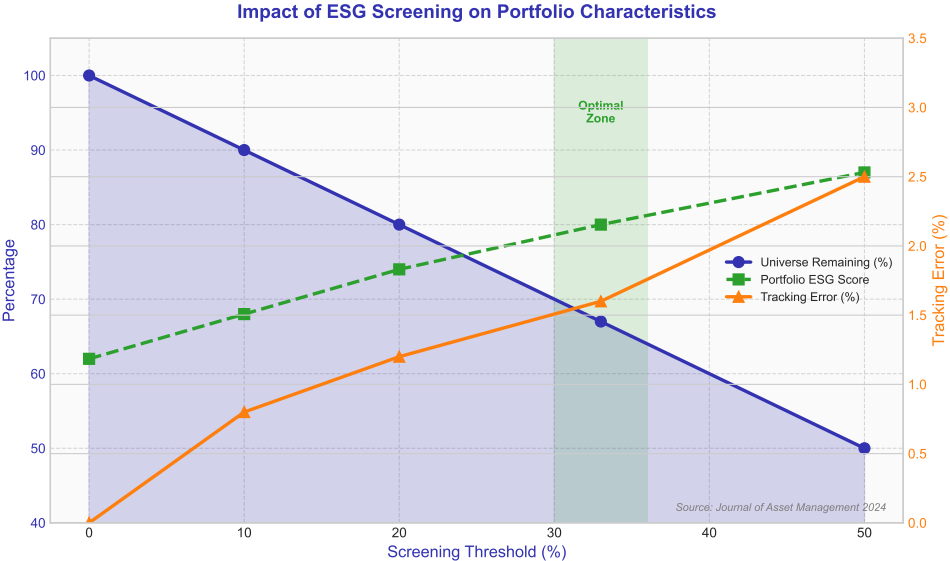**Adoption Rate: 61.9% of mutual funds**

Threshold Considerations

- Top 50%: Modest improvement, low TE
- Top 33%: Strong improvement, moderate TE
- Top 25%: Maximum ESG, higher TE

Trade-offs

- + Maintains sector exposure
- + Higher ESG score improvement
- + Encourages ESG competition
- - Still holds "brown" sectors
- - Requires ESG data quality

[Goal 2] Best-in-class maintains diversification while improving ESG profile by 18+ points

Impact of ESG Screening on Portfolio Characteristics

Source: Journal of Asset Management 2024

Definition

Overweight high-ESG securities and underweight low-ESG securities while maintaining benchmark-like risk.

Mathematical Formulation

$$w_i^{ESG} = w_i^{bench} + \alpha \cdot (ESG_i - \overline{ESG})$$

Where:

- w_i^{ESG}: Tilted portfolio weight
- w_i^{bench}: Benchmark weight
- α: Tilt intensity parameter
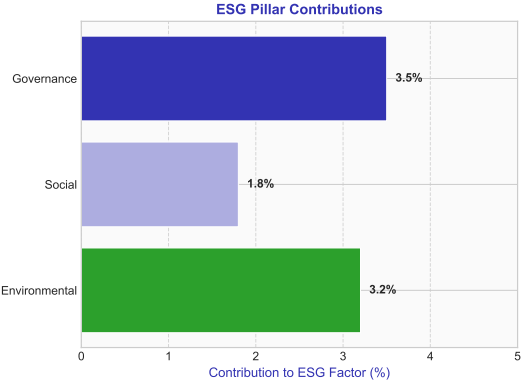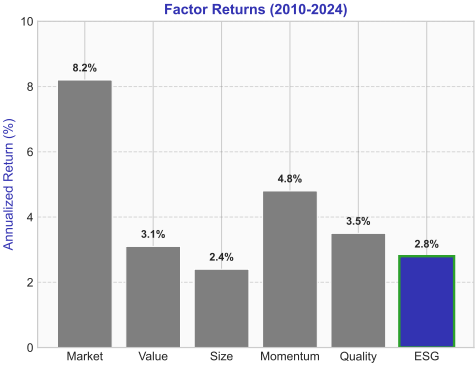- ESG_i: Security ESG score

Key Advantages

- Maintains full universe exposure
- Controllable tracking error
- Gradual ESG improvement
- Sector-neutral implementation

Implementation Considerations

- Tilt intensity calibration
- Constraint on active positions
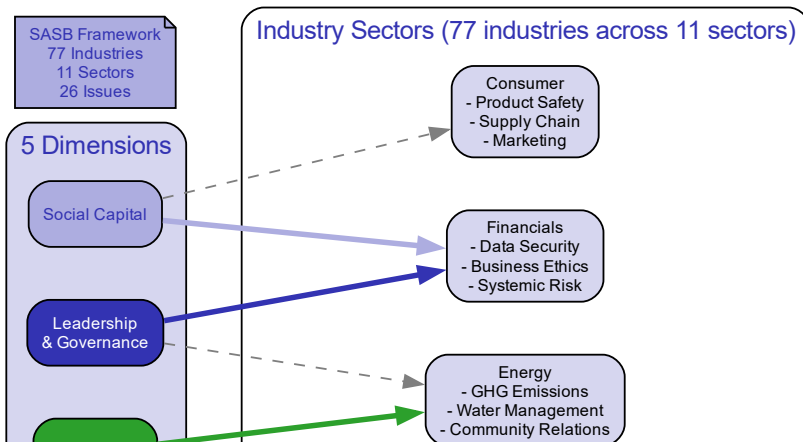- Transaction cost management
- Rebalancing frequency

[Goal 2] ESG tilting offers fine-grained control over ESG-return trade-off

ESG Factor Performance Attribution

Factor Returns (2010-2024)

- Market: 8.2%
- Value: 3.1%
- Size: 2.4%
- Momentum: 4.8%
- Quality: 3.5%
- ESG: 2.8%

Annualized Return (%)

ESG Pillar Contributions

- Governance: 3.5%
- Social: 1.8%
- Environmental: 3.2%

Contribution to ESG Factor (%)

[Goal 2] ESG factor (2.8% p.a.) competitive with traditional factors; Governance drives returns

SASB Materiality Map: Key Sectors

SASB Framework
77 Industries
11 Sectors
26 Issues

Industry Sectors (77 industries across 11 sectors)

5 Dimensions

Social Capital

Leadership
& Governance

Consumer
- Product Safety
- Supply Chain
- Marketing

Financials
- Data Security
- Business Ethics
- Systemic Risk

Energy
- GHG Emissions
- Water Management
- Community Relations

SASB Framework Structure

- 77 industry-specific standards
- 11 broad sectors
- 26 general issue categories
- 5 key dimensions

Five Key Dimensions

1. Environment
2. Social Capital
3. Human Capital
4. Business Model & Innovation
5. Leadership & Governance

Materiality by Sector

- **Energy:** GHG emissions, water
- **Financials:** Data security, ethics
- **Tech:** Privacy, labor practices
- **Healthcare:** Drug safety, access
- **Consumer:** Product safety, supply chain

Implementation

- Weight ESG factors by materiality
- Sector-specific scoring models
- Focus resources on material issues

[Goal 2] Materiality-based integration focuses on ESG factors that drive financial performance

Discovery Challenge: When 98% Can't Trust Their Data

The Puzzle

- 98% of companies struggle with ESG data integration (Bloomberg 2023)
- 63% cite coverage and quality as biggest concern
- 57% cite data quality as top concern
- Over 50% feel data insufficiently reliable for regulations
- Fortune 500: 20+ distinct metrics just for employee safety
- 75% in early stages of ESG assurance preparedness

Questions This Raises

- How can investors make decisions with unreliable data?
- Why is ESG data so inconsistent?
- What analytics can fix data quality issues?
- How do you standardize 20+ metrics for one variable?
- Can Python tools solve these problems?
- What's needed for reliable ESG analytics?

[Discovery 3] This puzzle will be resolved by Goal 3—Python analytics and data validation

Learning Goal 2: Summary

What We Achieved

- ✓ Compared integration strategies
- ✓ Analyzed negative vs. positive screening
- ✓ Quantified screening trade-offs
- ✓ Implemented ESG tilt formula
- ✓ Evaluated ESG factor performance
- ✓ Applied SASB materiality framework

Can You Now...

- Choose appropriate screening threshold?
- Calculate ESG tilt weights?
- Identify material ESG issues by sector?
- Estimate tracking error from screening?
- Design a best-in-class strategy?

Key Takeaway: Best-in-class screening at 33% threshold achieves 18pp ESG improvement with only 1.6% tracking error, making it the preferred strategy for ESG integration.

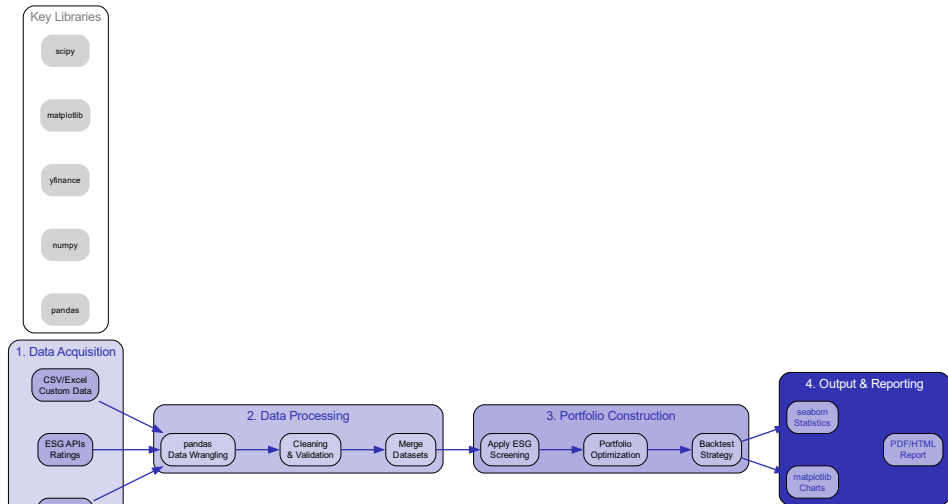**[Goal 2] Achieved - Now ready to implement these strategies in Python**

Learning Goal 3

Implement ESG Analytics with Python

applied — Apply - Hands-on technical implementation

Python ESG Analytics Workflow

Key Libraries

- scipy
- matplotlib
- yfinance
- numpy
- pandas

1. Data Acquisition
- CSV/Excel Custom Data
- ESG APIs Ratings
- yfinance

2. Data Processing
- pandas Data Wrangling
- Cleaning & Validation
- Merge Datasets

3. Portfolio Construction
- Apply ESG Screening
- Portfolio Optimization
- Backtest Strategy

4. Output & Reporting
- seaborn Statistics
- matplotlib Charts
- PDF/HTML Report

Stage 1: ESG Data Acquisition

Key Python Libraries

- `yfinance`: Free market data
- `pandas-datareader`: Multiple sources
- `requests`: API calls
- `openpyxl`: Excel file handling

Data Sources

- Yahoo Finance sustainability data
- CSV/Excel files (custom ESG scores)
- Commercial APIs (MSCI, Sustainalytics)
- Open datasets (CDP, GRI disclosures)

Sample Code Structure

```python
import yfinance as yf
import pandas as pd

# Get sustainability data
ticker = yf.Ticker("AAPL")
esg = ticker.sustainability

# Load custom ESG scores
esg_df = pd.read_csv("scores.csv")

# Merge with price data
merged = pd.merge(prices, esg_df)
```

[Goal 3] Data acquisition combines market data with ESG scores from multiple sources

Stage 2: Data Cleaning and Validation

Common Data Quality Issues
- Missing ESG scores
- Inconsistent date formats
- Duplicate entries
- Outlier values
- Stale data points

Cleaning Steps
1. Identify missing values
2. Remove duplicates
3. Standardize formats
4. Handle outliers
5. Validate score ranges

Validation Checks
```
# Check score ranges
assert df["esg"].between(0,100)

# Check completeness
missing = df.isnull().sum()
print(f"Missing: {missing}")

# Handle missing data
df["esg"].fillna(method="ffill")

# Remove duplicates
df.drop_duplicates(subset=["ticker"])
```

[Goal 3] Data quality critical: validate ranges, handle missing values, remove duplicates

Screening Implementation
```
# Best-in-class screening
threshold = df["esg"].quantile(0.33)
selected = df[df["esg"] > threshold]

# Calculate weights
selected["weight"] = 1/len(selected)

# Or market-cap weighted
cap_sum = selected["mcap"].sum()
selected["weight"] = selected["mcap"]/cap_sum
```

ESG Tilt Implementation
```
# Tilt formula
esg_mean = df["esg"].mean()
alpha = 0.01 # Tilt intensity

df["tilt"] = alpha * (df["esg"] - esg_mean)
df["new_wt"] = df["bench_wt"] + df["tilt"]

# Normalize weights
df["new_wt"] = df["new_wt"]/df["new_wt"].sum()
```

Constraint Considerations: Maximum position size, sector limits, turnover constraints

[Goal 3] Implementation follows mathematical formulation from Goal 2

Backtest Components

- Historical price data
- Point-in-time ESG scores
- Rebalancing schedule
- Transaction cost model
- Benchmark comparison

Key Metrics

- Annualized return
- Volatility (standard deviation)
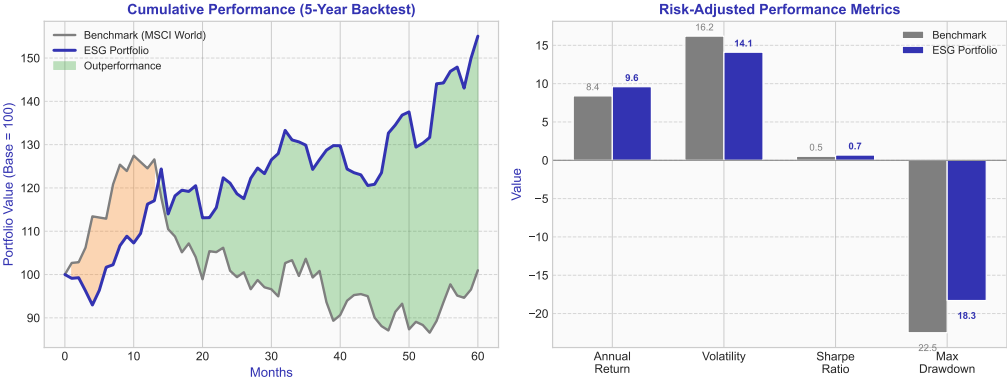- Sharpe ratio
- Maximum drawdown
- Tracking error vs. benchmark

Sample Backtest Loop

```python
# Monthly rebalancing
for date in rebal_dates:
    # Get current ESG scores
    scores = get_esg(date)
    # Apply screening
    weights = screen(scores)
    # Calculate returns
    ret = calc_return(weights)
    results.append(ret)

# Performance analysis
sharpe = np.mean(results)/np.std(results)
```
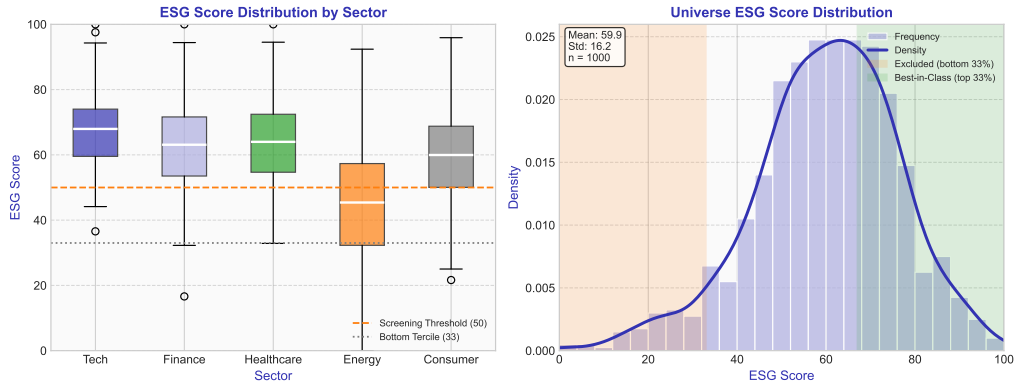
[Goal 3] Backtesting validates strategy before live implementation

ESG Portfolio Backtest Results

Cumulative Performance (5-Year Backtest)

Risk-Adjusted Performance Metrics

[Goal 3] ESG portfolio: +1.2% annual return, -2.1% volatility, +0.16 Sharpe ratio improvement

ESG Score Analysis Dashboard

ESG Score Distribution by Sector

Universe ESG Score Distribution

[Goal 3] Energy sector shows lowest ESG scores; Tech and Healthcare lead

Stage 4: Visualization and Reporting

Key Visualization Libraries

- `matplotlib`: Publication-quality charts
- `seaborn`: Statistical visualizations
- `plotly`: Interactive dashboards

Essential Visualizations

- ESG score distributions by sector
- Portfolio ESG evolution over time
- Risk-return scatter plots
- Factor attribution charts
- Correlation heatmaps

Report Generation

```
# Export to PDF
from reportlab.lib import colors
from reportlab.platypus import Table

# Create summary table
data = [["Metric", "ESG", "Bench"],
        ["Return", "9.6%", "8.4%"],
        ["Vol", "14.1%", "16.2%"],
        ["Sharpe", "0.68", "0.52"]]

table = Table(data)
doc.build([table, chart])
```

[Goal 3] Professional reporting combines performance metrics with visualization

What We Achieved

- ✓ Built data acquisition pipeline
- ✓ Implemented data validation
- ✓ Coded screening algorithms
- ✓ Developed backtest framework
- ✓ Created analysis visualizations

Can You Now...

- Acquire ESG data using Python?
- Implement best-in-class screening?
- Backtest an ESG strategy?
- Generate performance reports?

Week 3 Integration

1. **Goal 1:** Understood data landscape and rating divergence
2. **Goal 2:** Learned integration strategies and trade-offs
3. **Goal 3:** Implemented strategies in Python

Progression: WHY (divergence exists) → HOW MUCH (strategy impact) → HOW TO (Python code)

Week 3 Takeaway: ESG integration requires understanding data limitations, selecting appropriate strategies, and implementing robust analytical workflows.

[Goal 3] Complete: Foundation (Goal 1) → Strategies (Goal 2) → Implementation (Goal 3)