GROWING THE EFFICIENT FRONTIER ON PANEL TREES: EVIDENCE FROM THE SWEDISH STOCK MARKET

Erik Jin and Michael Brusis | Bachelor Thesis | SSE | October 2025

MOTIVATION:

Can panel-tree portfolio construction methods maintain their advantages over traditional characteristic-sorted portfolios in the Swedish stock market?

- Machine learning is transforming portfolio construction
- Panel Trees (P-Trees) show exceptional performance in US markets
  - Sharpe ratios > 6.3 in Cong et al. (2024)
- BUT: Developed and tested only on large, liquid markets with abundant data

The Challenge:

- Swedish market: ~300 stocks (vs. US ~2,500)
- Less liquidity, limited information
- Does sophisticated ML maintain performance in data-constrained environments?

LITERATURE REVIEW & CONTRIBUTION

Cong et al. (2024) - Panel Trees in US Market

- Advance efficient frontier beyond traditional sorted portfolios
- Global optimization: Maximize Sharpe ratio across all splits
- Capture non-linear, asymmetric interactions between characteristics
- Achieve Sharpe ratios > 6.37 (US market, 1981-2020)

Method: Systematically split stocks using firm characteristics to construct optimal leaf portfolios

Our Contribution

Testing P-Trees in Smaller Markets

The Challenge:

- Swedish market: ~300 stocks (vs. US ~2,500)
- Limited data environment

Our Innovation:

- Parameter scaling for market size
  - min_leaf_size: 20 → 3
- Multi-scenario validation

Impact: First evidence P-Trees work in data-constrained markets

DATA DESCRIPTION

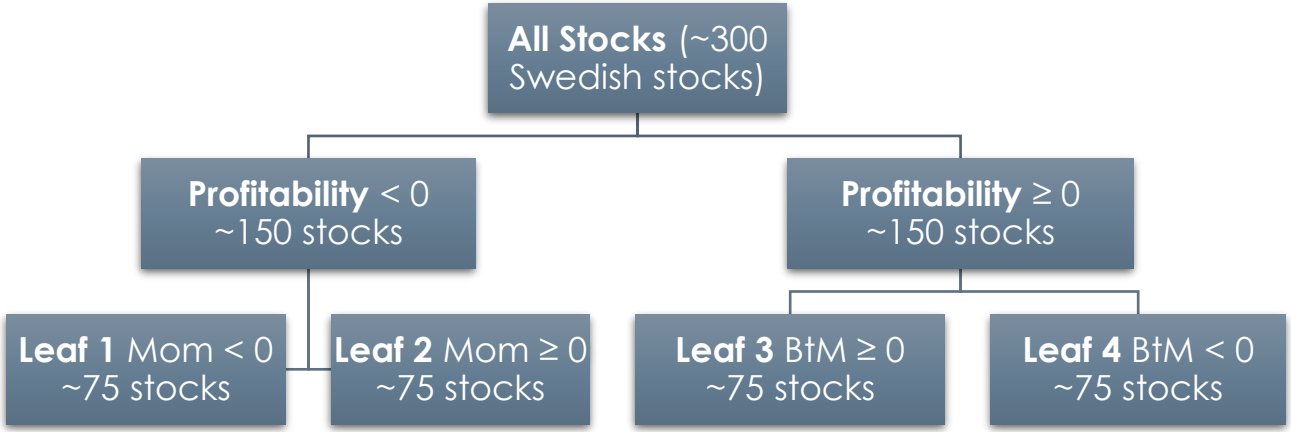
Period	Stocks	Observations	Frequency
1997-2020 Average:	1,176 firms ~300 stocks/month	102,823	Monthly

Data Sources: Finbas (market data) | LSEG/Refinitiv (fundamentals) | Swedish House of Finance (Fama-French factors)

19 FIRM CHARACTERISTICS

Category	Variables
Size	Market capitalization
Value	Book-to-market, E/P, CF/P, S/P, Price-to-assets
Momentum	12-month momentum, 1-month lagged return
Volatility	12-month volatility
Profitability	ROA, Gross profitability, CFO-to-assets
Growth	Sales growth, Asset growth
Investment	Capex-to-assets, Asset turnover
Leverage	Debt-to-equity
Quality	Asset quality
Trading	Share turnover

HOW THE ALGORITHM IDENTIFIES PROFITABLE PATTERNS



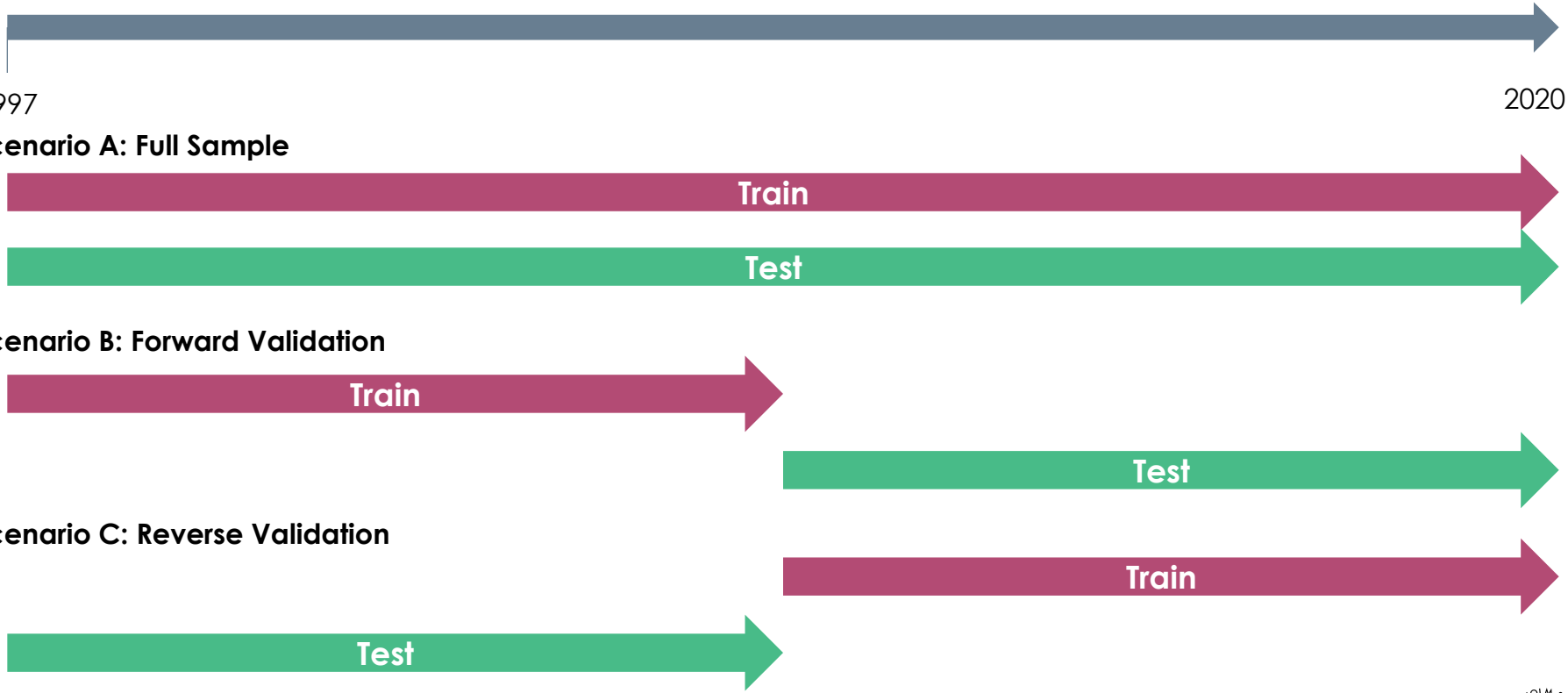
The Algorithm in 3 Steps:

1. Start with all stocks
2. Choose split that maximizes Sharpe ratio based on 19 characteristics
3. Combine optimally

Key Difference from Traditional Sorts:

- Traditional: One characteristic (e.g. momentum only)
- P-Tree: MULTIPLE characteristics + interactions
- Captures: "Momentum works differently for profitable vs. unprofitable stocks"

METHODOLOGY: THREE ROBUSTNESS SCENARIOS



MAIN RESULTS - PERFORMANCE SUMMARY

Scenario	Sharpe Ratio	CAPM Alpha	t-stat	FF3 Alpha	t-stat
A: Full Sample	2.74	21.84%	9.92***	21.78%	9.82***
B: Forward Test	4.21	21.70%	11.29***	21.48%	11.51***
C: Reverse Test	4.27	26.58%	15.00***	26.55%	14.90***

Note: *** indicates $p < 0.001$ (extremely statistically significant). Alphas are annualized.

Benchmark Comparison:
- Swedish Market Sharpe Ratio (1997-2020): 0.53
- P-Tree Sharpe Ratios: 2.74 to 4.27
- 5-8× improvement in risk-adjusted returns

Key Findings:
- Exceptional Sharpe ratios across all scenarios
- Highly significant alphas (21-27% annual)
- Consistent out-of-sample (Scenarios B & C)

CONCLUSION

Research Question:
Can panel-tree portfolio construction methods maintain their advantages over traditional characteristic-sorted portfolios in the Swedish stock market?

Evidence suggests YES, but with limitations

What we found:
- P-Trees generate significant abnormal returns in Swedish market
- Performance robust across different time periods
- Parameter scaling methodology shows promise

Limitations:
- Performance lower than US study (market size effect?)
- Only tested one parameter scaling approach
- Boosting effectiveness unclear
- Limited comparison to traditional Swedish sorted portfolios

Conclusion:
P-Trees can be successfully adapted to smaller markets, but further research needed on optimal parameter selection and direct comparisons to simpler methods.