A Case Study on the Tax-Aware Features in Axioma Portfolio

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We will explore the tax functionality of the Axioma Optimizer through the use of a fictional case study of a company named Efficient Managed Investments (EMI) that is managing investments on behalf of the Henderson Family Office. The case study will discuss how loss harvesting or tax liability can be included in the objective function as well as how gross and net tax constraints can be used when constructing a portfolio. We will also discuss how tax-sensitive optimizations can be backtested using the Axioma backtester or automated using the Axioma API.

Background

Efficient Managed Investments (EMI) is responsible for 1,000 tax-aware portfolios for high-net-worth individuals, insurance companies, foundations, endowments and taxable trusts. EMI currently uses the Axioma Portfolio Optimizer and API to automate the management and reporting of these portfolios with little manual intervention.

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On Dec. 28, 2015, the Henderson Family Office instructed EMI to withdraw $20 mil. from its $46 mil. Russell 1000 Dividend Yield portfolio to fund an international non-US portfolio. The Henderson family would like both the withdrawal and the investment in the non-US portfolio to occur on Dec. 31, 2015. The family wants to ensure that the withdrawal realizes the least amount of gains as possible, but still adheres to its mandate. They also want to keep costs low and don't want to pay for non-US custodians, so they have instructed EMI to only purchase US cross-listed foreign securities like ADRs to fund the international portfolio.

The portfolio was scheduled to be traded as part of an automated rebalancing process on Dec. 31, so EMI was able to exclude the portfolio from the automated process and reschedule it for Feb. 1, 2017, which is the first trading day after the wash-sale period.

EMI is now faced with three issues which it needs to address to properly perform the Henderson family's request.

Three Issues

1. Minimize the tax impact of the withdrawal from the Russell 1000 Dividend Yield Portfolio and keep the active risk within the Henderson family's mandate

2. Fund the international strategy with US cross-listed securities

3. Evaluate the tax efficiency of the international strategy using cross-listed securities

Proposed Solutions

1. US Large Cap Dividend Yield portfolio withdrawal

The Henderson Family's Russell 1000 Dividend Yield portfolio is a traditionally managed tax-aware portfolio, which minimizes the active risk of the portfolio and realizes no net gains while also targeting a dividend yield roughly 2% greater than the Russell 1000. This portfolio has a unique feature in that it contains a 9.7% weight in IBM at a low-cost basis that the family is not allowed to sell. IBM has an adverse effect on the active risk of the portfolio, but thankfully it has a dividend yield that is much larger than that of the Russell 1000.

In table 1, which is a screenshot from the Axioma Portfolio Optimizer, we see that the Russell 1000 Dividend Yield portfolio has an active risk of 2.38%, which is driven by stock-specific risk and two factors, Dividend Yield and Size. Both of these factors are in line with the portfolio's strategy to buy companies that issue dividends much larger than the Russell 1000 while also taking advantage of stock-level tax losses.

Table 1

Settings | Initial Portfolio | Edit Strategy | Buy/Sell Editor | Trades | Final Portfolio

Summary | Risk Decomposition | Asset Details - Account+Benchmark | Holding Lots | Transact

Risk	Factor Volatility (%)	Active Exposure	Factor MCAR	Risk Decomposition	
				Standard Deviation (%)	% of Variance
Total Risk				15.85%	100.00%
Benchmark Risk				16.55%	100.00%
Total Active Risk				2.38%	100.00%
Specific Active Risk				1.59%	44.69%
Factor Active Risk				1.77%	55.31%
US4AxiomaMH.Style				1.38%	33.56%
US4AxiomaMH.Dividend Yield	1.06%	0.82	0.00	0.87%	13.26%
US4AxiomaMH.Size	6.71%	-0.11	-0.02	0.72%	9.03%
US4AxiomaMH.Medium-Term Momentum	3.83%	-0.11	-0.02	0.41%	2.99%
US4AxiomaMH.MidCap	2.07%	0.12	0.00	0.25%	1.14%
US4AxiomaMH.Earnings Yield	2.06%	0.12	0.00	0.25%	1.07%
US4AxiomaMH.Market Sensitivity	5.01%	-0.05	0.00	0.23%	0.90%
US4AxiomaMH.Leverage	1.34%	0.16	0.00	0.22%	0.83%
US4AxiomaMH.Growth	1.21%	-0.16	0.00	0.19%	0.64%
US4AxiomaMH.Volatility	5.77%	0.03	0.00	0.18%	0.58%
US4AxiomaMH.Value	2.46%	0.06	0.01	0.15%	0.42%
US4AxiomaMH.Exchange Rate Sensitivity	0.97%	-0.12	0.00	0.12%	0.24%
US4AxiomaMH.Liquidity	1.78%	0.04	0.00	0.07%	0.08%
US4AxiomaMH.Profitability	2.20%	-0.01	0.00	0.03%	0.01%
Covariance					2.37%
US4AxiomaMH.Industry				1.01%	17.80%
US4AxiomaMH.Market				0.00%	0.00%
Covariance					3.95%

The Portfolio Optimizer has an easy feature for bucketing securities by different classifications, such as GICS sectors or security type, to get more analytics. For this example, we grouped by cash and securities to get a weighted average dividend yield for the security type. Now we can see that the Dividend Yield in the Russell 1000 is 2.03% while the strategy has a dividend yield of 3.77%. In general, the strategy's target is 2%, but there is always some drift between rebalances.

Russell 1000 Dividend Yield 12/31/2015

Summary | Risk Decomposition | Asse

Symbol	Net Name Count	Dividend Yield
Securities	1033	2.03%
Cash	0	0.00%

Henderson Family Portfolio 12/31/2015

Summary | Risk Decomposition | Asse

Symbol	Net Name Count	Dividend Yield
Securities	293	3.77%
Cash	1	0.00%

The portfolio's summary in table 2 details the current state of the Russell 1000 Dividend Yield Portfolio. It was funded in 1989 with cash and IBM stock. More than $18 mil. of the portfolio's $46 mil. is in unrealized net gains.

Currently, the high yield portfolio's total risk is about one percentage point below that of the Russell 1000—a smaller difference than average, but high yield is still below the Russell 1000, which suggests high yield is not substantially riskier, at least in terms of predicted volatility, than the large-cap US market.

Table 2

	Risk
15.85%	Total Risk
16.11%	Total Risk with Alpha Factor (25.0)
15.74%	Total Factor Risk
1.87%	Total Specific Risk
0.93	Historical Beta (from risk model)
0.95	Predicted Beta (from model/benchmark)
26.06%	Total Return at Risk (%) (5.0%)
$11,900,805.20	Total Value at Risk ($) (5.0%)
0.98	Coefficient of Determination
16.55%	Benchmark Risk
2.38%	Active Risk
3.60%	Active Risk with Alpha Factor (25.0)
1.77%	Active Factor Risk
1.59%	Active Specific Risk
-0.05	Active Predicted Beta
3.92%	Active Return at Risk (%) (5.0%)
$1,789,269.97	Active Value at Risk ($) (5.0%)
0.13	Active Coefficient of Determination
0.62	Active Share
	Portfolio Details
292	Long Count
$43,853,928.29	Long Value ($)
96.04%	Long Value (%)
$1,806,083.33	Cash Value ($)
3.96%	Cash Value (%)
$45,660,011.63	Net Value
$45,660,011.63	Reference Value
	Tax Details
$0.00	Tax Liability
$1,963,859.17	Unrealized Short-term Gains
$676,467.92	Unrealized Short-term Losses
$17,651,305.39	Unrealized Long-term Gains
$710,755.76	Unrealized Long-term Losses

IBM alone has $1.427 mil. in unrealized gains as seen in the holding lots summary.

Settings | Initial Portfolio | Edit Strategy | Buy/Sell Editor | Trades | Final Portfolio | Strategy | Initial v

Summary | Risk Decomposition | Asset Details - Account+Benchmark | Holding Lots | Transaction Lots

Symbol	Shares	Open Date	Open Price	Total Cost	Current Price	Current Value	Gain/Loss	Term
IBM	32,171.58	12/31/1989	$93.25	$2,999,999.83	$137.62	$4,427,452.68	$1,427,452.85	long-term
ICPT	37.35	12/31/2014	$156.00	$5,826.20	$149.35	$5,577.84	-$248.36	short-term
INCY	913.06	12/31/2012	$16.61	$15,165.88	$108.45	$99,021.04	$83,855.16	long-term
INCY	1,000.81	12/31/2013	$50.63	$50,670.84	$108.45	$108,537.47	$57,866.63	long-term
INTC	315.18	12/31/2008	$14.66	$4,620.57	$34.45	$10,858.03	$6,237.46	long-term
INTC	875.19	12/30/2011	$24.25	$21,223.45	$34.45	$30,150.43	$8,926.98	long-term
INTC	3,386.34	12/31/2010	$21.03	$71,214.73	$34.45	$116,659.41	$45,444.68	long-term
INTC	826.67	12/31/2007	$26.66	$22,039.14	$34.45	$28,478.94	$6,439.80	long-term
INTC	4,298.78	12/31/2014	$36.29	$156,002.80	$34.45	$148,093.04	-$7,909.76	short-term
INTC	3,062.29	12/31/2009	$20.40	$62,470.63	$34.45	$105,495.75	$43,025.12	long-term
IP	2,207.93	12/31/2008	$11.63	$25,685.53	$37.70	$83,239.01	$57,553.48	long-term
IPG	1,221.13	12/30/2011	$9.73	$11,881.62	$23.28	$28,427.96	$16,546.34	long-term
IR	475.91	12/30/2011	$24.32	$11,574.66	$55.29	$26,313.30	$14,738.64	long-term
ITT	1,279.16	12/30/2011	$19.33	$24,726.13	$36.32	$46,459.03	$21,732.90	long-term
ITW	511.51	12/31/2007	$53.54	$27,386.00	$92.68	$47,406.32	$20,020.32	long-term
ITW	332.15	12/31/2008	$35.05	$11,642.02	$92.68	$30,784.10	$19,142.08	long-term

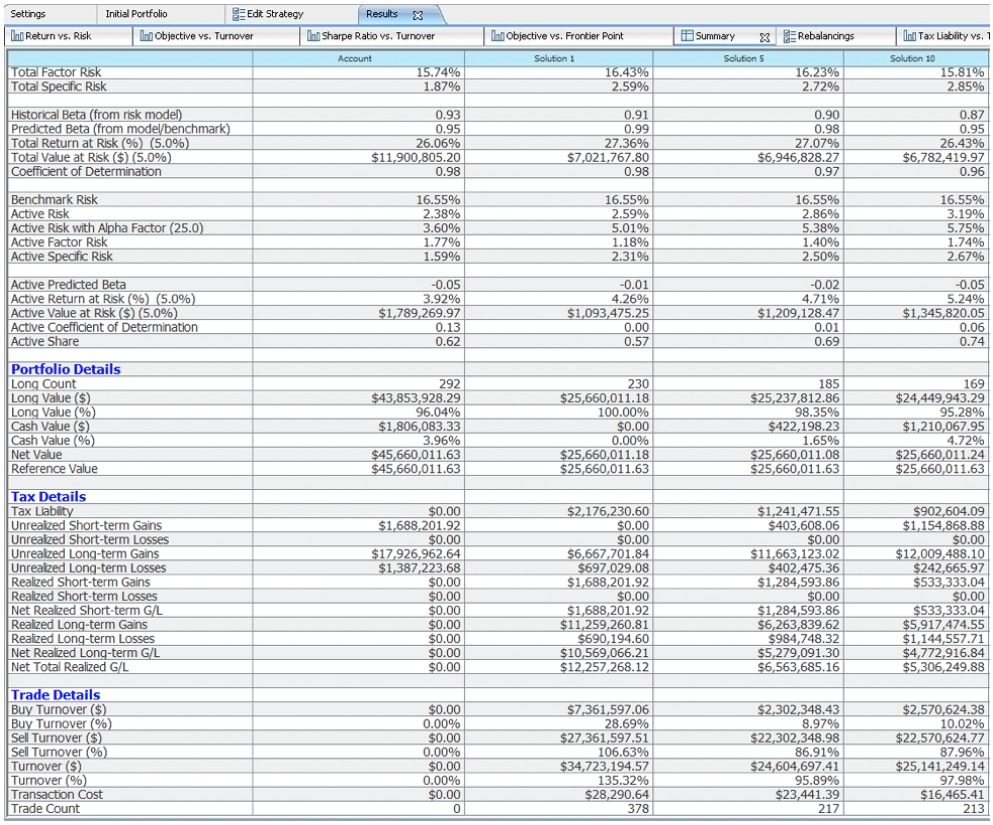
The family had asked to liquidate $20 mil. of its portfolio, but it still can't sell IBM. The family wants to minimize the gains realized by selling the other stocks during this liquidation while still minimizing active risk.

EMI can't use the current optimization strategy constraints placed on the portfolio to withdraw the $20 mil. the family requested, since IBM would then represent a 17.25% weight in the final portfolio. Because the portfolio has a lot of gains and very few losses, simply putting it into an automated process will likely be disastrous and not lead to results the Henderson family would want to see.

To perform a proper evaluation of the $20 mil. withdrawal, EMI decided to run an efficient frontier on the current strategy by adjusting the trade-off between active risk and net gains.

The current active risk is 2.38% and as seen in Table 3, the final portfolio's active risk after the withdrawal ranges from 2.38% to 3.19%, resulting in a $903,000 to $2.18 mil. tax liability.

Table 3



Settings | Initial Portfolio | Edit Strategy | Results

Return vs. Risk | Objective vs. Turnover | Sharpe Ratio vs. Turnover | Objective vs. Frontier Point | Summary | Rebalancings | Tax Liability vs. T

	Account	Solution 1	Solution 5	Solution 10
Total Factor Risk	15.74%	16.43%	16.23%	15.81%
Total Specific Risk	1.87%	2.59%	2.72%	2.85%
Historical Beta (from risk model)	0.93	0.91	0.90	0.87
Predicted Beta (from model/benchmark)	0.95	0.99	0.98	0.95
Total Return at Risk (%) (5.0%)	26.06%	27.36%	27.07%	26.43%
Total Value at Risk ($) (5.0%)	$11,900,805.20	$7,021,767.80	$6,946,828.27	$6,782,419.97
Coefficient of Determination	0.98	0.98	0.97	0.96
Benchmark Risk	16.55%	16.55%	16.55%	16.55%
Active Risk	2.38%	2.59%	2.86%	3.19%
Active Risk with Alpha Factor (25.0)	3.60%	5.01%	5.38%	5.75%
Active Factor Risk	1.77%	1.18%	1.40%	1.74%
Active Specific Risk	1.59%	2.31%	2.50%	2.67%
Active Predicted Beta	-0.05	-0.01	-0.02	-0.05
Active Return at Risk (%) (5.0%)	3.92%	4.26%	4.71%	5.24%
Active Value at Risk ($) (5.0%)	$1,789,269.97	$1,093,475.25	$1,209,128.47	$1,345,820.05
Active Coefficient of Determination	0.13	0.00	0.01	0.06
Active Share	0.62	0.57	0.69	0.74
Portfolio Details				
Long Count	292	230	185	169
Long Value ($)	$43,853,928.29	$25,660,011.18	$25,237,812.86	$24,449,943.29
Long Value (%)	96.04%	100.00%	98.35%	95.28%
Cash Value ($)	$1,806,083.33	$0.00	$422,198.23	$1,210,067.95
Cash Value (%)	3.96%	0.00%	1.65%	4.72%
Net Value	$45,660,011.63	$25,660,011.18	$25,660,011.08	$25,660,011.24
Reference Value	$45,660,011.63	$25,660,011.63	$25,660,011.63	$25,660,011.63
Tax Details				
Tax Liability	$0.00	$2,176,230.60	$1,241,471.55	$902,604.09
Unrealized Short-term Gains	$1,688,201.92	$0.00	$403,608.06	$1,154,868.88
Unrealized Short-term Losses	$0.00	$0.00	$0.00	$0.00
Unrealized Long-term Gains	$17,926,962.64	$6,667,701.84	$11,663,123.02	$12,009,488.10
Unrealized Long-term Losses	$1,387,223.68	$697,029.08	$402,475.36	$242,665.97
Realized Short-term Gains	$0.00	$1,688,201.92	$1,284,593.86	$533,333.04
Realized Short-term Losses	$0.00	$0.00	$0.00	$0.00
Net Realized Short-term G/L	$0.00	$1,688,201.92	$1,284,593.86	$533,333.04
Realized Long-term Gains	$0.00	$11,259,260.81	$6,263,839.62	$5,917,474.55
Realized Long-term Losses	$0.00	$690,194.60	$984,748.32	$1,144,557.71
Net Realized Long-term G/L	$0.00	$10,569,066.21	$5,279,091.30	$4,772,916.84
Net Total Realized G/L	$0.00	$12,257,268.12	$6,563,685.16	$5,306,249.88
Trade Details				
Buy Turnover ($)	$0.00	$7,361,597.06	$2,302,348.43	$2,570,624.38
Buy Turnover (%)	0.00%	28.69%	8.97%	10.02%
Sell Turnover ($)	$0.00	$27,361,597.51	$22,302,348.98	$22,570,624.77
Sell Turnover (%)	0.00%	106.63%	86.91%	87.96%
Turnover ($)	$0.00	$34,723,194.57	$24,604,697.41	$25,141,249.14
Turnover (%)	0.00%	135.32%	95.89%	97.98%
Transaction Cost	$0.00	$28,290.64	$23,441.39	$16,465.41
Trade Count	0	378	217	213

EMI presented the Henderson family with three scenarios from the frontier above – one with the lowest active risk, the lowest tax liability and a balance between active risk and tax liability. The Henderson Family selected the balanced scenario because they felt it gave them the best trade-off between active risk and tax liability. Although this scenario realizes $6.56 mil. in net gains for a tax liability of $1.24 mil., the portfolio's active risk

only increased 40 basis points (bps) and IBM was not sold.

Table 4

			Realized						
	Active Risk	Tax Liability	Short-term Gains	Short-term Losses	Net Short-term G/L	Long-term Gains	Long-term Losses	Net Long-term G/L	Net Total G/L
Lowest Active Risk	2.38%	$2,176,230.60	$1,688,202	$0	$1,688,202	$11,259,261	$690,195	$10,569,066	$12,257,268
Maintain Active Risk	2.72%	$1,241,471.55	$1,284,594	$0	$1,284,594	$6,263,840	$984,748	$5,279,091	$6,563,685
Lowest Tax Liability	3.19%	$902,604.09	$533,333	$0	$533,333	$5,917,475	$1,144,558	$4,772,917	$5,306,250

We will review many of the common tax constraints and objective terms used in section 2, where we discuss the international portfolio funding. Appendix 1 list all of the constraints and objective terms available in the Axioma Optimizer.

EMI is now ready to focus its attention on the funding of the international portfolio.

2. International portfolio funding with US cross-listed international securities

EMI found it challenging to fund the international portfolio because the securities all had to trade in the US and needed to be tied to international non-US securities. The first thing EMI did was create a robust universe of international names traded within the US.

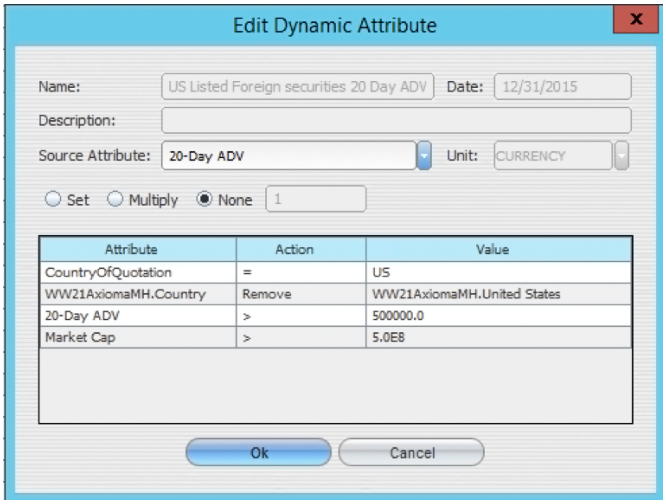
EMI constructed this universe within the Axioma Portfolio Optimizer by creating a dynamic attribute, which is a rule, filter, or scaling that you can set in the Axioma Portfolio, making it easy to store modified values in the system based on your preferences. To do this, EMI needed to satisfy a few requirements to ensure the stocks traded in the US, had local securities outside the US, were liquid and were not very small firms.

EMI used the following filters for the dynamic attribute (see table 3 for how to create this dynamic attribute within the Axioma Portfolio Optimizer):

- Country of quotation equal to the US
- Country factor risk to be non-US
- Market Cap greater than $500 mil.
- Average daily volume of at least $500,000

This resulted in 616 stocks with enough liquidity to fund this portfolio with minimal market impact.

Table 5: Dynamic Attribution Creation

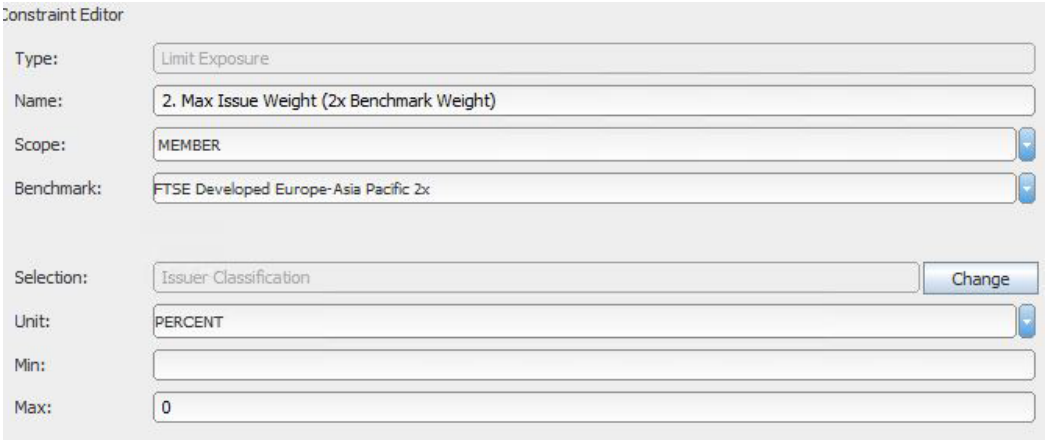


Note: In practice, this universe of securities should be reviewed to ensure it has enough liquidity on a daily basis and truly is tied to a foreign listing.

Now that EMI has the universe of securities to purchase, it wants to ensure that no security has a large active weight versus the underlying local security in the benchmark. EMI wants to ensure that small securities in the index don't have a weight that is too disproportional to their weight in the benchmark. To do this, EMI will set a limit that no security's weight in the portfolio can exceed 2x the weight in the benchmark. In addition, the Hendersons do not want to own any cross-listed security where the underlying isn't a member of the index.

In Appendix 2, we show what this would look like within the Axioma Portfolio Optimizer.

Table 6



EMI solved the problem of no security having a weight of 2x the local member by adding a constraint in the optimizer that said a max issuer weight can be no more than 2x the FTSE Benchmark. This constraint also addressed the issue of not owning a name that isn't in the benchmark, since non-benchmark names can only have a weight of 2x the benchmark weight of zero.

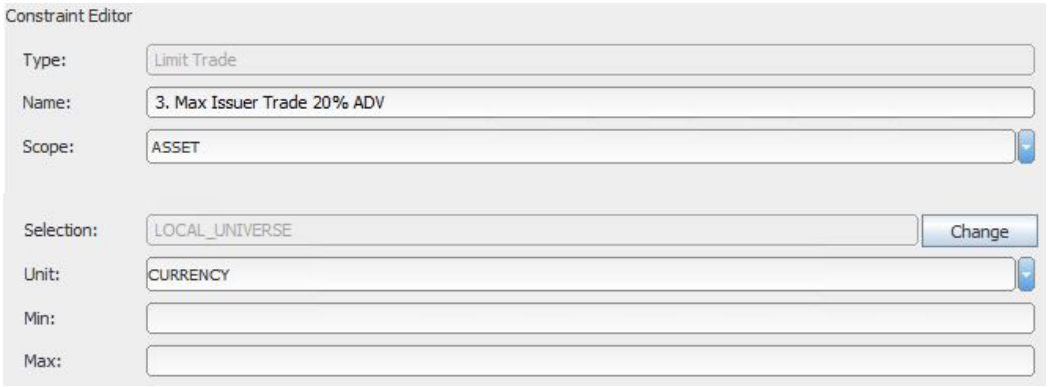
Table 7 also details all the constraints used to construct this portfolio.

1) The first constraint is a budget constraint that is used to ensure that the final portfolio's value will be equal to the $20 mil. invested.

2) The second constraint is the Max Issuer Weight of 2x the FTSE Benchmark.

3) The third constraint is to ensure that EMI isn't funding this portfolio with more than 20% of the 20-day average daily volume (ADV). On an ongoing basis, it will require all trades to be less than 5% ADV, but for the initial funding it is comfortable with 20% ADV.

Table 7



4) The Min/Max Region Sector constraint ensures that for each region EMI defines, the GICS sectors are within +/- 3% of the benchmark.

Table 8

5) The unchecked constraint in table 8, which is max turnover, isn't used during the initial construction, but allows for future optimizations to place a maximum 8% turnover on any rebalance.

6) EMI placed a maximum bet of +/-20 bps relative to the benchmark for any style factor. This allows for the optimizer to minimize the amount of factor bets made during construction.

7) This constraint doesn't allow for any net short-term gains. Since we are starting with cash, this will be used in the next rebalance.

Table 9

8) During ongoing rebalances, EMI wants to avoid selling any gross short-term gains if they will become long-term gains in 60 days. To prevent this, EMI applied an Almost Long Term constraint. This restricts the selling of any gross short-term gains if they are 60 days from becoming long-term.

Table 10

9) This constraint ensures that only 10 bps to 25 bps of cash will be in the final portfolio.

Lastly, EMI added an objective function to minimize the active risk of the portfolio relative to the FTSE Benchmark, as well as minimizing the transaction cost. The transaction cost model combined with the Goldman Sachs Shortfall Model approximates the transaction and Shortfall Market Impact of a security.

Table 11

Objective↑	Active	Term
Minimize Active Risk. Costs and NEt Gains (Minimize)	◉	
		activerisk
		transactioncost
		Goldman Sachs Shortfall Model
		Net Gains

Note: We didn't import ADR custody and pass-through fees, as this was out of the scope of this paper.

EMI is now able to construct a portfolio that has 79 bps tracking error with 450 securities, and every security in the portfolio has a local issue in the benchmark. Only a handful of the names have a weight less than 5 bps, and the largest active weight is Samsung (since it doesn't have a cross-listed issue) at -1%, leading to an underweight in Korea of 3.14%.

Table 12

Settings | Edit Strategy | Buy/Sell Editor | Trades | Final Portfolio | Strate

Summary | Risk Decomposition | Asset Details - Account | Holding Lots

Risk	Factor Volatility (%)	Active Exposure	Factor MCAR	Risk Decomposition	
				Standard Deviation (%)	% of Variance
Total Risk				16.87%	100.00%
Benchmark Risk				16.74%	100.00%
Total Active Risk				0.79%	100.00%
Specific Active Risk				0.55%	48.18%
Factor Active Risk				0.57%	51.82%
WW21AxiomaMH.Style				0.31%	14.89%
WW21AxiomaMH.Country				0.44%	30.91%
WW21AxiomaMH.Korea, Republic of	16.45%	-3.14%	-0.05	0.52%	42.77%
WW21AxiomaMH.Hong Kong	19.75%	0.71%	0.01	0.14%	3.18%
WW21AxiomaMH.Australia	17.10%	0.76%	0.02	0.13%	2.72%
WW21AxiomaMH.Finland	20.64%	-0.57%	0.03	0.12%	2.22%
WW21AxiomaMH.Denmark	18.78%	0.58%	0.03	0.11%	1.87%
WW21AxiomaMH.Sweden	18.90%	0.39%	0.03	0.07%	0.87%
WW21AxiomaMH.Japan	21.43%	0.33%	0.03	0.07%	0.79%
WW21AxiomaMH.United Kingdom	16.84%	0.41%	0.03	0.07%	0.76%

Now that the international portfolio is ready to be funded, EMI will evaluate the tax efficiency of the international portfolio.

3. Evaluating the Tax Efficiency of the International Portfolio

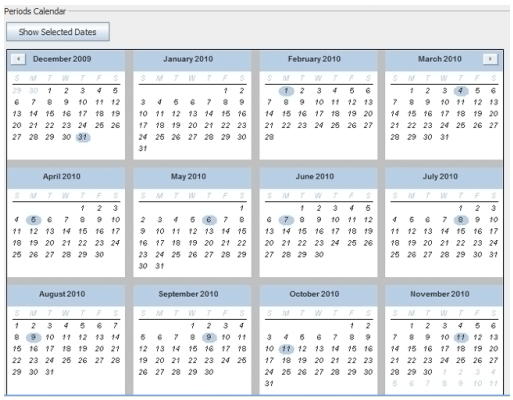
EMI will perform a backtest using the same strategy as the funding to better understand how to evaluate the tax efficiency of the international portfolio. EMI just needs the average annual active after-tax return of the portfolio to be able to show the Henderson family that the strategy it selected can be tax efficient over time.

The Axioma Backtester will simulate trading the portfolio on the first trading day after 31 days due to the wash-sale rule. This will save EMI a tremendous amount of work, since the Axioma Backtester will also keep track of all the gains and losses in these trades over time.

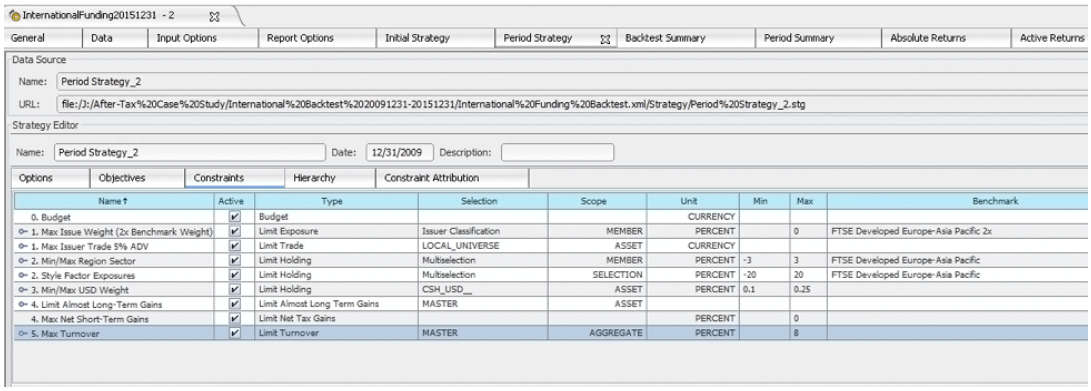
EMI utilizing the Backtester

1) EMI created a CSV file with trading dates from Dec. 31, 2009, to Dec. 31, 2015, that are outside the wash-sale period and not on holidays and imported it into the Axioma Backtester, as seen below in table 13.

Table 13



2) To define the strategy for the backtest, EMI used the same strategy as the initial funding, but used 5% 20-day ADV for period strategies as well as 8% max turnover and added the max net short-term gains and almost longer-term gains constraints.



Based on the backtest, the international portfolio would have underperformed the FTSE index by 85 bps on an annualized pre-tax basis from 2010 to 2015. Once EMI includes the tremendous value of the tax loss harvesting, the backtest realized 75 bps in value-add on an annualized basis, resulting in only a 10 bps underperformance on an after-tax basis, versus the FTSE Developed Market Index.

Table 14

	Active Risk	Active Risk w/ Alpha Factor	Realized Active Risk	Total Return	Benchmark Return	Active Return	Realized Gains/Losses Short-Term	Realized Gains/Losses Long-Term	Beginning Period	Value Added($)	Value Added(%)	After-Tax Total Return	After-Tax Active Return
2010	1.41%	3.02%	2.34%	7.77%	9.29%	-1.51%	(1,602,909)	0	20,000,000	561,018	2.81%	10.58%	1.29%
2011	0.96%	2.66%	2.25%	-13.44%	-11.73%	-1.71%	(544,181)	(335,127)	21,554,040	240,733	1.12%	-12.32%	-0.59%
2012	1.24%	2.77%	2.13%	20.23%	18.87%	1.36%	(209,783)	(495,050)	18,657,470	147,682	0.79%	21.02%	2.16%
2013	0.90%	2.55%	2.24%	20.39%	22.02%	-1.63%	176,977	(45,230)	22,432,091	(55,158)	-0.25%	20.14%	-1.88%
2014	0.70%	2.44%	1.98%	-5.96%	-4.53%	-1.43%	324,931	(105,856)	27,005,504	(97,847)	-0.36%	-6.32%	-1.79%
2015	0.72%	2.41%	1.98%	0.15%	-0.03%	0.17%	(244,654)	(107,656)	25,395,298	101,777	0.40%	0.55%	0.58%
Annual				4.09%	4.94%	-0.85%					0.75%	4.84%	-0.10%

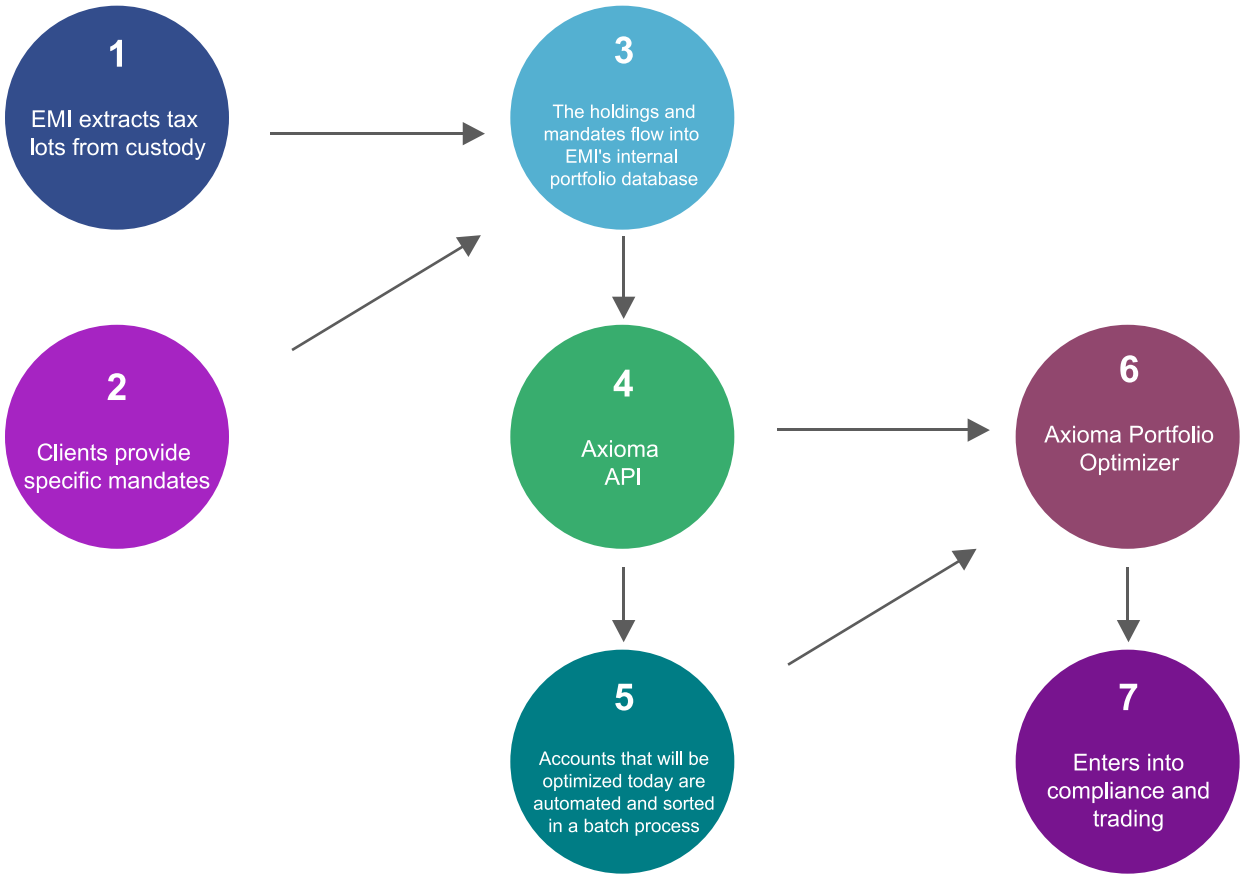
EMI used the Axioma Optimizer to efficiently perform the withdrawal and funding for the Henderson family, but could it have just as easily been performed using EMI's current automated process?

Automated Process as a Solution

1. Can the withdrawal of the US Large Cap Dividend Yield portfolio and the funding of the international portfolio be included in EMI's automated process?

EMI's Automated and scalable optimization process

The automated process EMI incorporates can be explained by looking at Chart 1 below.



1. Tax-Lot Holding Extraction

EMI's automated process starts with extracting all 1,000 portfolio accounts at the tax-lot level from its custodian on a daily basis. The reason all 1,000 portfolio accounts are extracted on a daily basis is because a client may ask to perform a withdrawal or funding of their portfolio at any point, and EMI needs to be ready to perform this task as quickly as possible with zero operational risk.

2. Internal Portfolio Database

All these accounts are then stored within EMI's internal portfolio investment database, which has all the characteristic information each account requires to be managed properly, such as the:

- Tax lots
- Benchmark
- Last trade date
- Next trade date (which is based on the first trading day after the wash-sale period)
- Compliance lists
- Realized gains/losses

3. Client-Specific Mandate

The mandates include the relevant benchmark, compliance lists, and the Axioma Optimization Strategies created for each unique account.

There are many strategies used, but most try to harvest as many losses as possible, while not exceeding a specific tracking error. Others prefer to minimize tracking error and take no net gains while following a compliance list.

Axioma API

EMI has created an internal application using Java as its selected software language to interact with the Axioma API, Optimizer, EMI's internal portfolio database, and trading system. Other available languages include R, MatLab, C++, and Python. We also offer web services.

1) Each day, the API does the following things before the optimization batch is performed: calculates all the risk details for each account, makes compliance checks on all accounts, checks if there are any unexpected cash flows, and calculates the short- and long-term unrealized gains and losses.

2) The API uses a predetermined schedule to identify the accounts that need to be traded.

3) For these identified accounts, an optimization is performed for each account, based on its specific mandate and strategy.

4) Another layer of compliance checks is performed as a second check.

5) An aggregate report for the final portfolios is created.

    a. This report contains essential items needed to review the individual accounts for a third check to ensure no mistakes are made.

6) The trades for each account are aggregated and sent to the trading desk.

7) If any accounts had an unexpected cash flow and can still be traded today, the account is exported out of the batch and traded manually using the export workspace functionality.

4. Automated Accounts Identified

Each day, between 20 and 100 portfolios are traded within the automated process. Last trading day and benchmark are the key drivers as to when an account is traded, ensuring the account is outside of the wash-sale period and helping to manage the trade execution process.

5. Axioma Portfolio Optimizer

For the accounts exported from the batch process and traded today, the Axioma Portfolio Optimizer is the manual method to optimize accounts to stay within their mandates and targeted strategy. Once the final portfolio has been constructed, the trade list is exported to a network drive, where the trading system captures the trade list and sends it to the trading desk.

6. Trading System

The aggregated trade list is then sent to the trading system. Once the trades have been executed, the individual trade's characteristics as well as the tax-related information are sent to the custodian.

For most typical trading, EMI would use the automated process outlined above. However, there are a few limited exceptions where it would require manual intervention. In this use case, EMI needed to make some adjustments to its optimization strategy that required manual intervention.

Let us first investigate why the withdrawal wouldn't be possible within the automated process:

1) $20 mil. cash flow needs to be added to the Axioma strategy

2) The constraints need to be adjusted for both net short-term and long-term gains

3) The tracking error of the portfolio will likely need to be increased to minimize realized gains

Adding the funding to the automated process has a couple issues:

1) The batch trades are based on the benchmark and this FTSE Benchmark isn't scheduled to trade on December 31

2) The $20 mil. funding of cross-listed securities will need special attention, since it may take hours to fully fund this international portfolio of cross-listed assets.

Summary

EMI was able to use the Axioma Optimizer to efficiently withdraw $20 mil. from its Russell 1000 Dividend Yield strategy while still maintaining its dividend yield target and active risk mandate. The international funding was able to be performed using cross-listed securities while keeping active risk low and not owning any securities that don't have a local issuer in the benchmark. EMI was also able to present to the Henderson family how efficient their international strategy has been over the past six years.

EMI's automated process is very elaborate and uses the full functionality and integration between Axioma's API and Portfolio Optimizer. However, we also saw the full flexibility of the products because EMI was able to easily make manual interventions to support changes in optimization strategy to serve its clients' needs.

EMI has built a process that currently handles 1,000 accounts, but is scalable for a tremendous amount of growth.

If you would like to discuss how Axioma can help you create and manage optimized tax portfolios, please contact sales@axioma.com.

Appendix

Appedix 1

Objective Tax-related Terms

There are three broad tax-related objective terms that can be specified within the objective function. The reason to put tax-related terms into the objective function is to allow the optimizer to determine the best trade-offs for you between taxes and active risk, for example.

The ideal place to have tax terms in the objective function is during a backtest, since it is very difficult to determine the exact amount of gains you would want to realize if gains needed to be realized to meet certain constraints.

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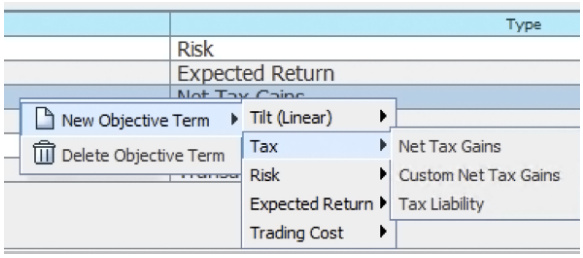
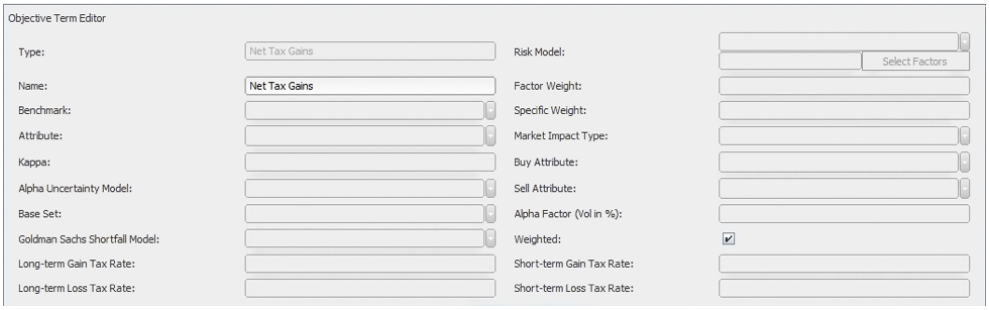


1) Net Tax Gains



a. This term captures the Net Gains minus the Net Losses and is generally used to harvest losses

b. When the Weighted checkbox is ticked, the net short term gains are multiplied by the short-term tax rate and the net long-term gains are multiplied by the long-term tax rate

2) Custom Net Tax Gains

a. This is exactly like the net tax gains, but allows you to override the short- and long-term tax rates assigned to the account

3) Tax Liability

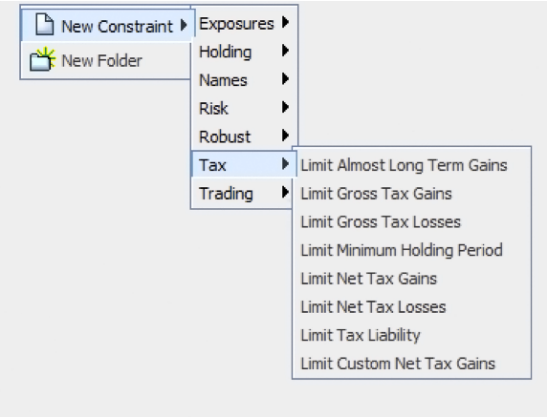
a. The tax liability term measures the amount of tax liability realized in a rebalance trade

b. This term is generally used to minimize the portfolio's tax liability when rebalancing and thus minimizes the amount of taxes paid during a rebalance

c. The tax liability term doesn't differentiate from zero tax liability and negative tax liability, so this term should be used when looking to minimize or avoid paying taxes and not loss harvesting

Tax-Related Constraints

For all taxable accounts, the following are all the tax-related constraints that can be applied to the optimization.



1) Limit Almost Long-Term Gains

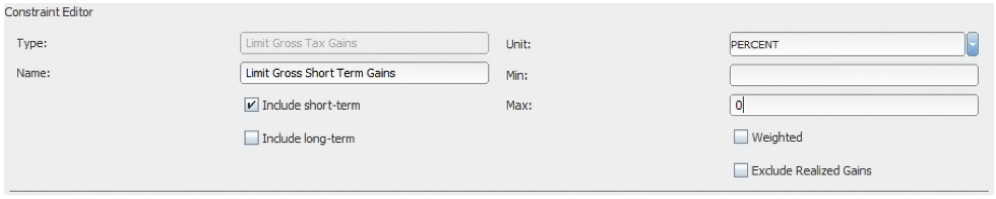
a. Defers the realization of short-term gains if they will become long-term within a specific number of days (60 in the example below).

2) Limit Gross Tax Gains

a. This constraint sets minimum and maximum limits on the amount of gross gains realized for either short-term, long-term, or a combination of the two.

b. By ticking the weighted box, you add the tax rate for each term into the calculation.

c. In the example below, we want to avoid gross short-term gains.

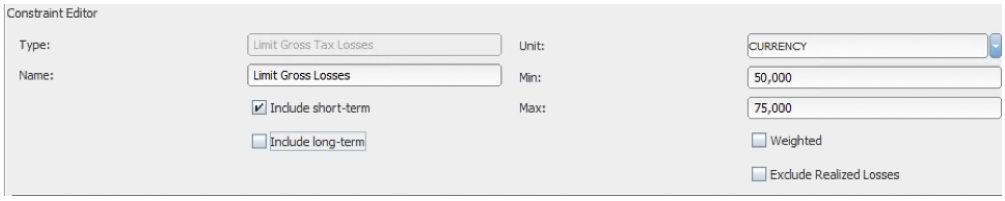


3) Limit Gross Tax Losses

a. This allows the user to set a minimum and maximum gross losses realized for either short-term, long-term, or a combination of the two.

b. By ticking the weighted box, you add the tax rate for each term into the calculation.

c. The example below allows targets the optimizer to realize $50,000 to $75,000 in realized gross losses.



4) Limit Minimum Holding Periods

a. This constraint ensures that all or selected tax lots will be held for a minimum amount of days before being sold.

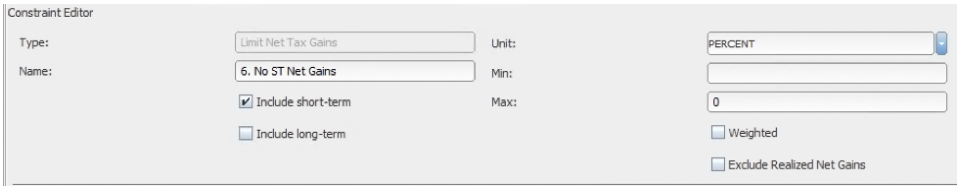
b. The example below ensures that the tax lots of stocks that paid their dividend since last rebalance will not be sold unless they have been owned for at least 61 days. This ensures the dividends are qualified.

5) Limit Net Tax Gains

a. Allows you to set minimum and maximum net realized tax gains for short-term, long-term, or both.

b. By ticking the weighted box, you add the tax rate for each term into the calculation.

c. The example below avoids realizing any net short-term gains.

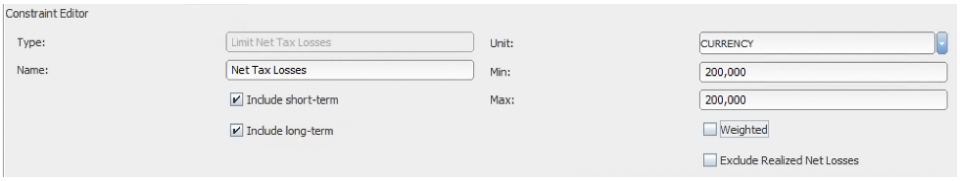


6) Limit Net Tax Losses

a. Allows you to set minimum and maximum net realized tax losses for short-term, long-term, or both.

b. By ticking the weighted box, you add the tax rate for each term into the calculation.

c. The example below targets realizing exactly $200,000 in net losses.



7) Limit Tax Liability

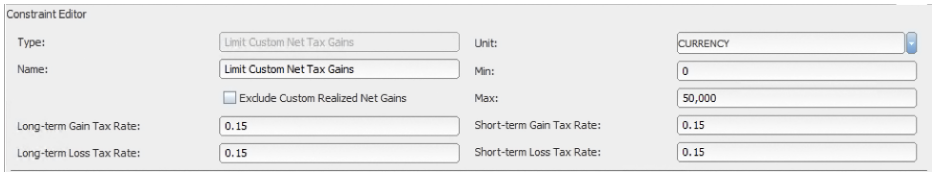
a. Allows you to target the maximum tax liability you want to realize based on the tax rates you specify.

b. The example below targets realizing a maximum of $15,000 in taxes paid.

8) Limit Custom Net Tax Gains

a. Similar to the limit net tax gains, this constraint places minimum and maximum realized net max gains using custom tax rates, which override the rates placed within the account.

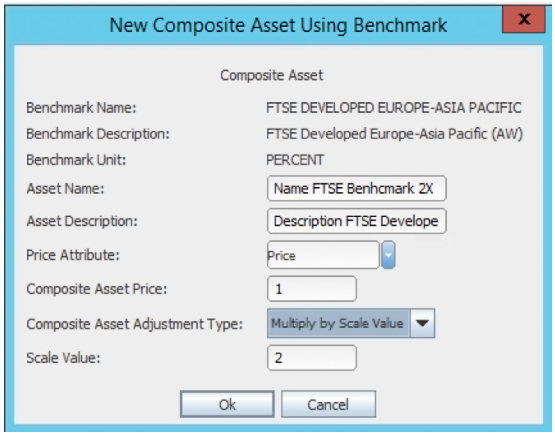
b. The example below overrides the tax rates placed on the account to be the corporate ordinary income tax rate of 15%, since we only want to realize a max of $50,000.



Appendix 2

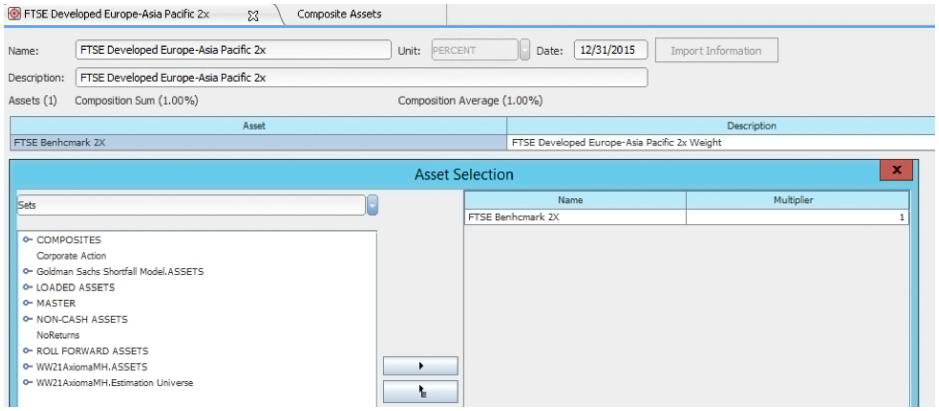
EMI had to do three things:

1) Create a composite asset that was 2x the weight of the FTSE index.

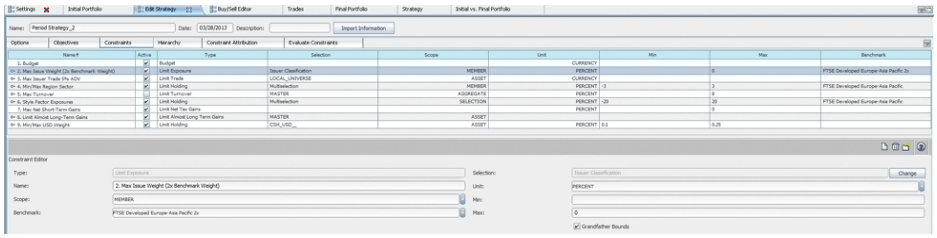


2) Create a benchmark with the composite as the only asset.

a. This is done to allow for the benchmark to have securities whose weight sum to 200%.



3) Add the max issuer weight of 2x the FTSE Benchmark.



Contact us to learn more about how Axioma can bring more information and insights to your investment process.

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