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Kirkland, March 11th, 2022

Hello Travis,

Please find code and instructions for our bond strategy attached.

Thank you,
Best regards.

Felix Bertram

Summary

We coded the bond strategy from report #03 for Amibroker and took the following notes:

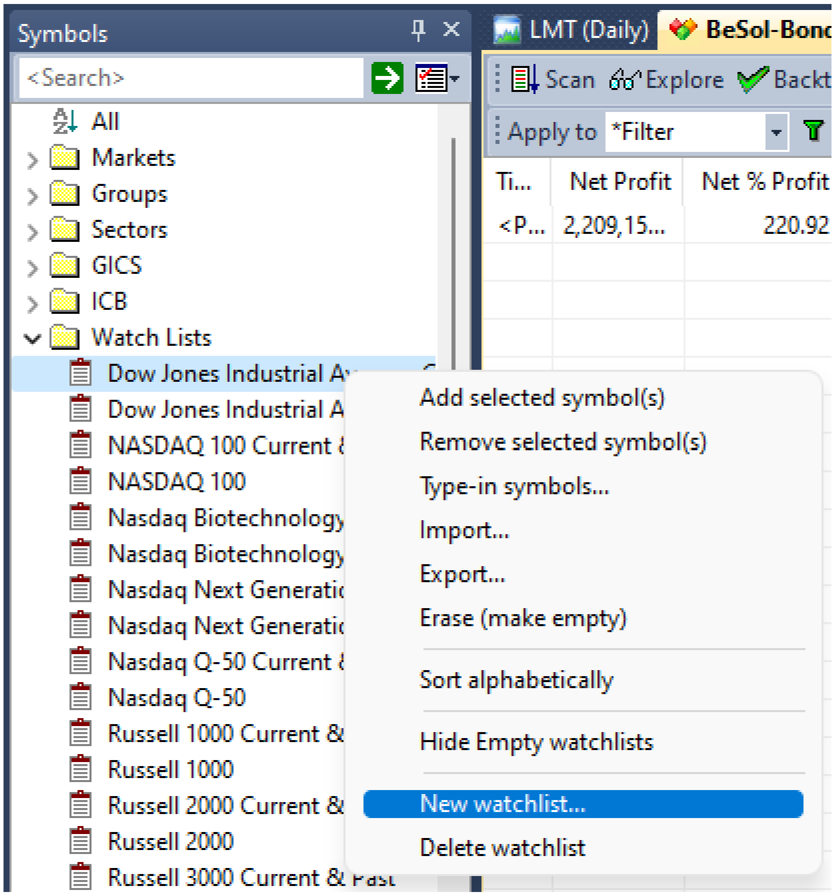
- Implementation for Amibroker was straightforward and did not pose any major challenges.
- Amibroker does not offer the same data sources that TuringTrader does. In particular, we are missing access to economic data from FRED. To remedy this, we substituted these time series with data available from Norgate. These series are similar in nature, but not identical. Consequently, the strategy's result are not 100% identical to the results we obtained on the TuringTrader platform.
- Amibroker does not offer a convenient method of splicing asset quotes with backfills. Consequently, we are not able to backtest the strategy prior to the inception dates of the ETFs used. Because we rely on prior research conducted on the TuringTrader platform, this has been deemed acceptable.
- Because the results of our Amibroker implementation inevitably differ from our results on TuringTrader, we decided to adjust it's parameters by brute-force optimization. This steps leads to further deviations from the results presented in report #03.
- Amibroker's backtester is not a good fit for portfolio strategies. The APIs are optimized for simple and speedy execution, but not well suited for complex strategies that rotate through a universe of assets and dynamically adjust position sizes. While all of this is possible using a custom backtesting procedure, it results in convoluted code, which is hard to read and hard to debug. Further, the platform does not offer any features for creating portfolios of strategies.
- We learned a lot about Amibroker in the past few days, but we are certainly not Amibroker pros. Some of the hurdles we have seen might be due to our lack of experience with the platform. Also, our implementation might not be as tight as it could be, if developed by a seasoned Amibroker developer. Nonetheless, our assessment that the platform is ultimately not well-suited for complex portfolio strategies and meta-portfolios stands.

Installation

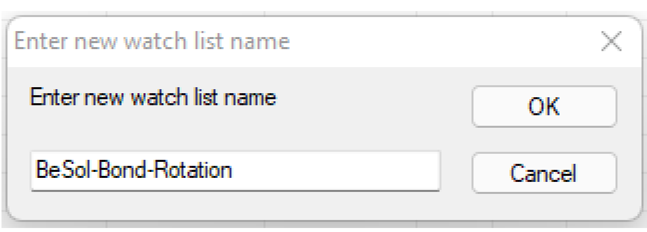
To make sure that the strategy works the same way it does on our system, follow these steps:

Create Watchlist

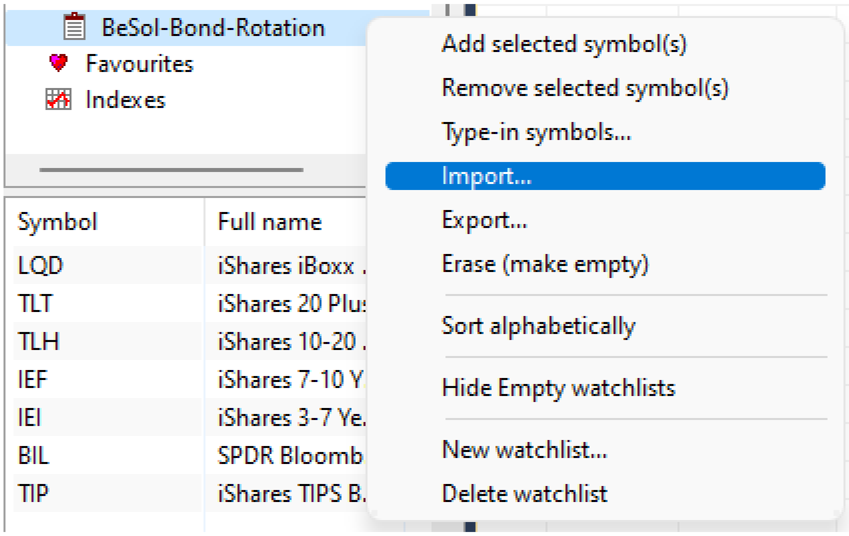
The strategy works on a pre-defined universe. The strategy code specifically expects certain ETFs to be present. If any of these ETFs are missing, or substituted with other ETFs, the strategy might behave differently.



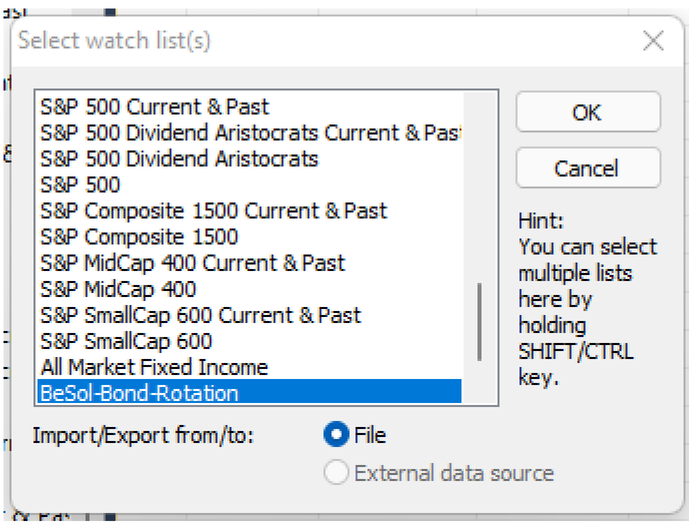
Right click under *Watch Lists* and choose the option *New watchlist*.



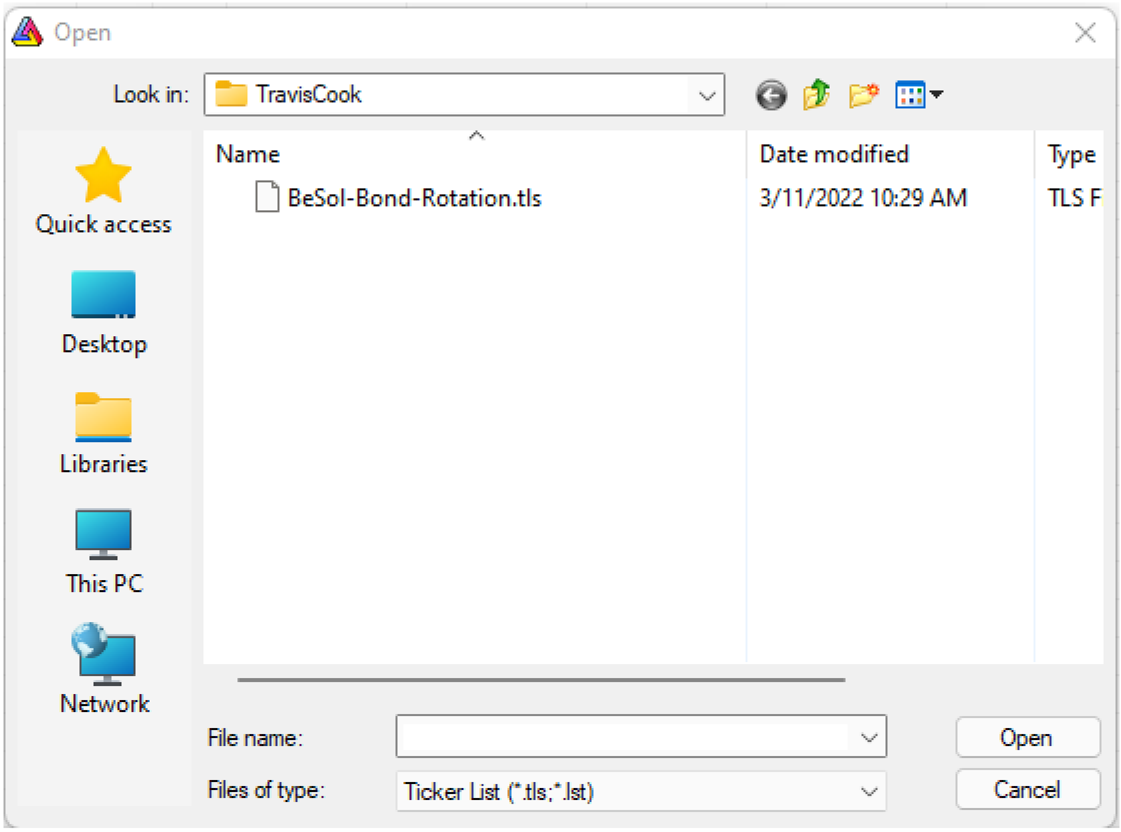
When prompted for the name of the new watch list enter *BeSol-Bond-Rotation*.



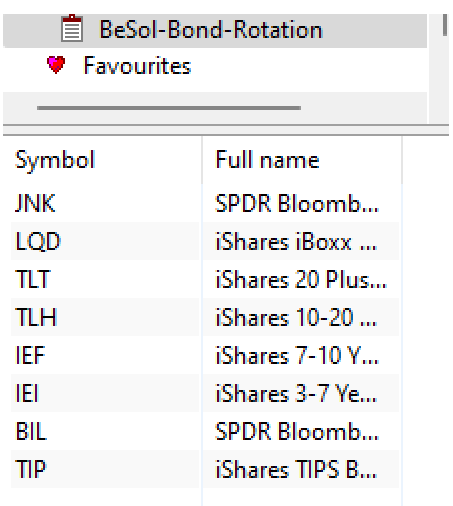
Find your newly created watchlist, right click, and select *Import*.



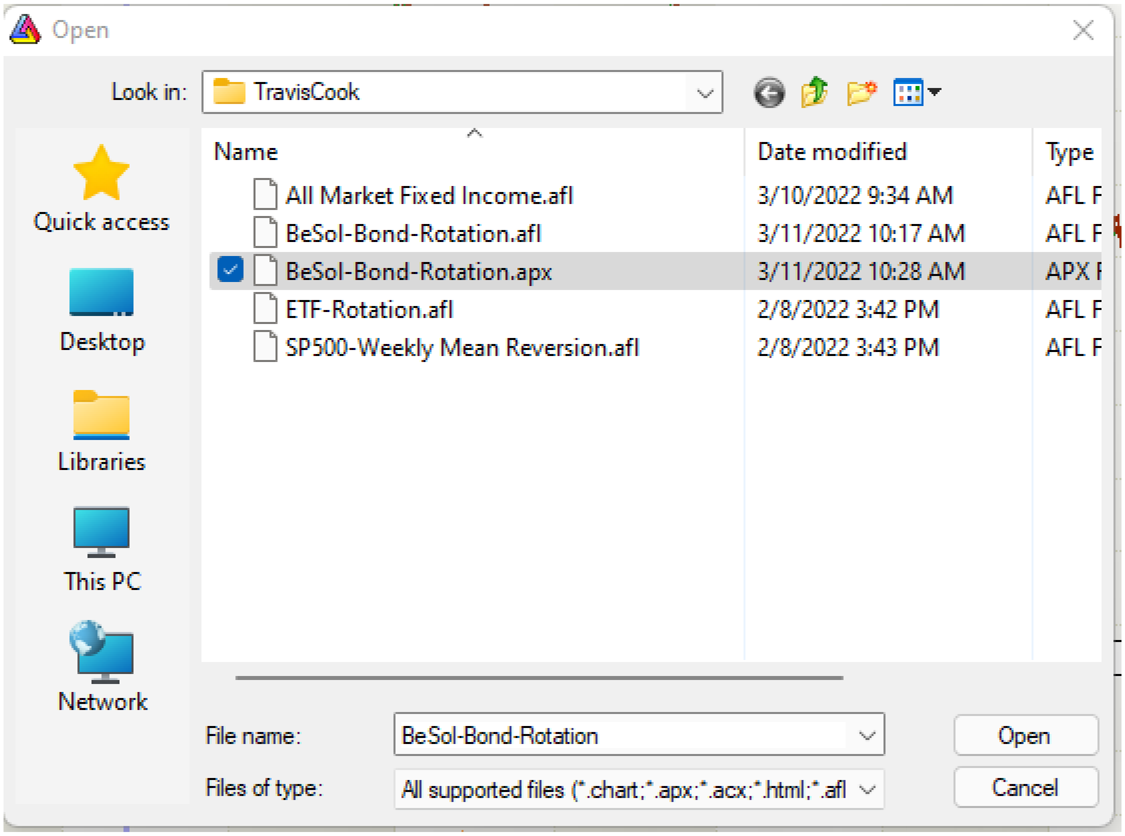
When prompted to select the watch list, you should find it pre-selected. Click *OK* to confirm.



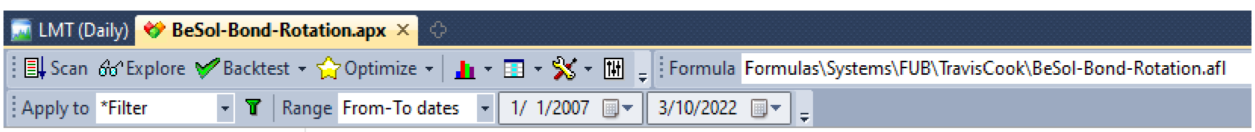
Navigate to the file *BeSol-Bond-Rotation.tls* that we provided and click *Open*.



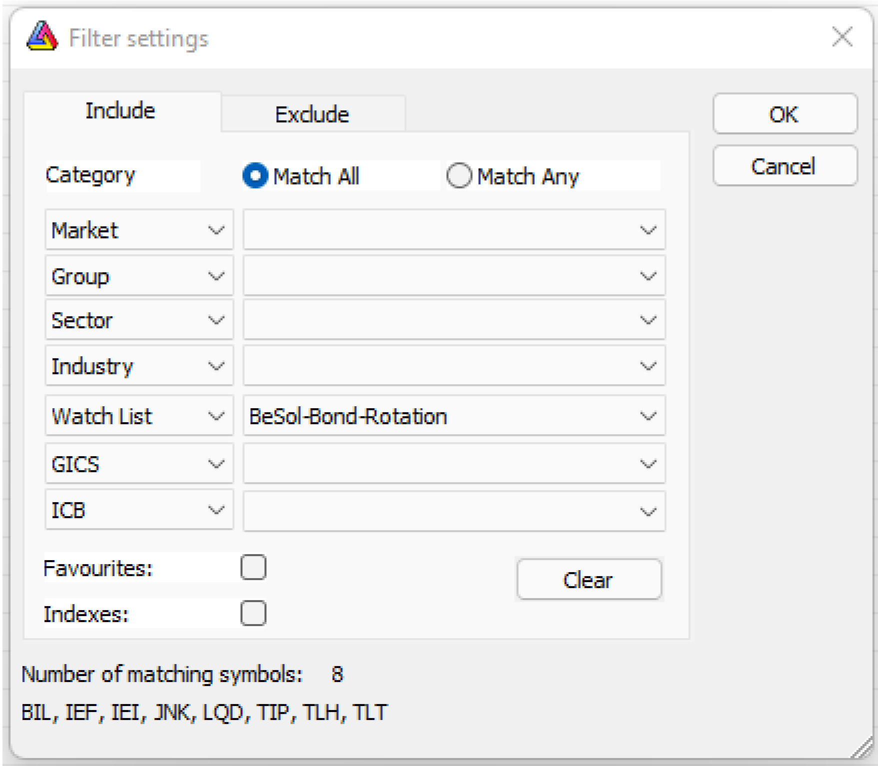
You should see the following eight symbols in you watchlist: JNK, LQD, TLT, TLH, IEF, IEI, BIL, TIP.



Navigate to the file *BeSol-Bond-Rotation.apx* that we provided and click *Open*.

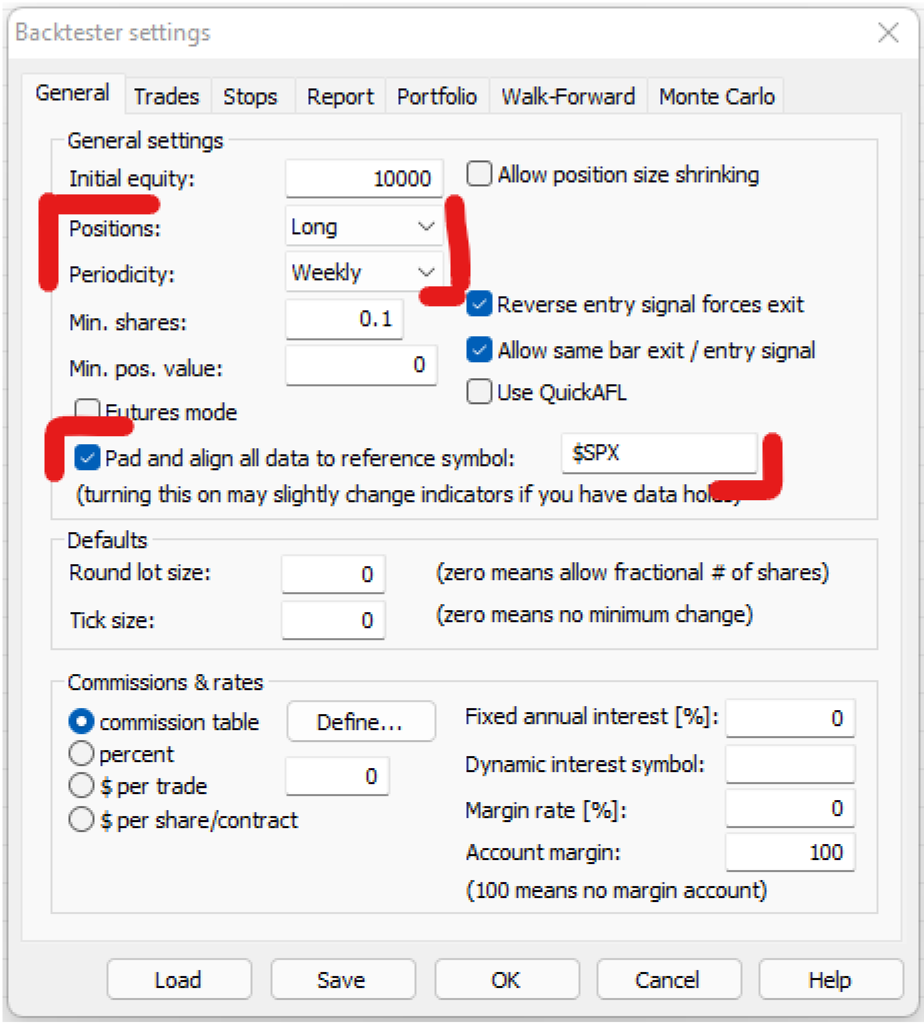


Confirm that the strategy is applied to a *Filter*, and that the start date is *01/01/2007*.



Click the green filter icon, and confirm that the Filter uses the *BeSol-Bond-Rotation watchlist*.

Click the tool icon, and confirm the following settings:



Most of the settings are defined inside the strategy's code. However, the following settings must be adjusted here:

- Positions
- Periodicity
- Pad and align

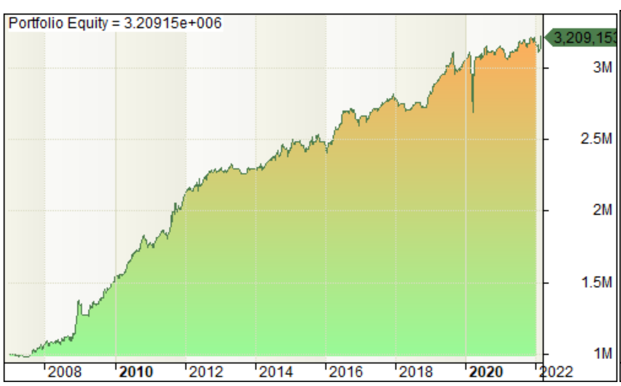
You are now ready to run the strategy.

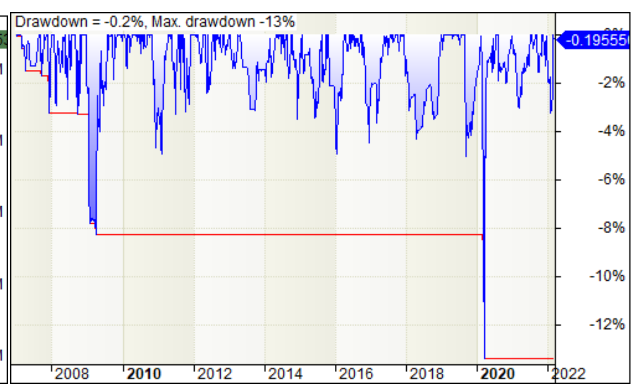
Backtest

In our testing, we achieved the following results with weekly rebalancing:

Statistics

	All trades	Long trades	Short trades
Initial capital	1000000.00	1000000.00	1000000.00
Ending capital	3209152.63	3209152.63	1000000.00
Net Profit	2209152.63	2209152.63	0.00
Net Profit %	220.92%	220.92%	0.00%
Exposure %	95.63%	95.63%	0.00%
Net Risk Adjusted Return %	231.00%	231.00%	N/A
Annual Return %	7.98%	7.98%	0.00%
Risk Adjusted Return %	8.34%	8.34%	N/A
Total transaction costs	86995.56	86995.56	0.00
Max. trade drawdown	-326360.75	-326360.75	0.00
Max. trade % drawdown	-20.51	-20.51	0.00
Max. system drawdown	-414596.19	-414596.19	0.00
Max. system % drawdown	-13.35%	-13.35%	0.00%
Recovery Factor	5.33	5.33	N/A
CAR/MaxDD	0.60	0.60	N/A
RAR/MaxDD	0.62	0.62	N/A
Profit Factor	3.00	3.00	N/A
Payoff Ratio	1.71	1.71	N/A
Standard Error	145479.15	145479.15	0.00
Risk-Reward Ratio	1.03	1.03	N/A
Ulcer Index	1.96	1.96	0.00
Ulcer Performance Index	1.32	1.32	N/A
Sharpe Ratio of trades	0.36	0.36	0.00
K-Ratio	0.16	0.16	N/A





Strategy Code

```
//==============================================================================
// Project:     Travis Cook 2022
// Name:        BeSol-Bond-Rotation.afl
// Description: Bond Rotation, based on Heine's Bond Trading Model
// History:     2022iii10, FUB, created
//------------------------------------------------------------------------------
// Copyright:   (c) 2011-2022, Bertram Solutions LLC
//              http://www.bertram.solutions
//==============================================================================

//------------------------------------------------------------------------------
// strategy parameters

//WKS = 1; // bars per week: 1 for weekly, 5 for daily bars
switch (Interval(0))
{
	case inDaily: WKS = 5; break;
	case inWeekly: WKS = 1; break;
	default:
		WKS = 1; // dummy required to display error message
		Error("must use daily or weekly Interval");
		break;
}

BOND_NUM = 2; //Optimize("BOND_NUM", 2, 1, 3, 1); // default: 2
BOND_PER = 10 * WKS; //Optimize("BOND_PER", 10*5, 6*WKS, 26*WKS, WKS); // default: 10 weeks
YIELD_LT_PER = 7 * WKS; //Optimize("YIELD_LT_PER", 7*WKS, 4*WKS, 13*WKS, WKS); // default: 7
weeks
YIELD_ST_PER = 10 * WKS; //Optimize("YIELD_ST_PER", 6*5, 4*WKS, 13*WKS, WKS); // default: 8 weeks
UTILITY_IDX_PER = 4 * WKS; //Optimize("UTILITY_INDEX_PER", 10 * WKS, 3 * WKS, 26 * WKS, WKS); //
default: 6 weeks
COMMODITY_IDX_PER = 6 * WKS; //Optimize("COMMODITY_INDEX_PER", 20 * WKS, 3 * WKS, 26 * WKS, WKS);
// default: 17 weeks
SAFE_PER = 38 * WKS; //Optimize("SAFE_PER", 38 * WKS, 8 * WKS, 52 * WKS, WKS); // default: 38
weeks
SPX_FAST = 2 * WKS; // default: 2 weeks
SPX_SLOW = 10 * WKS; // default: 10 weeks

//------------------------------------------------------------------------------
// strategy universe
// this strategy must be applied to a watchlist with the following tickers:
// - JNK: SPDR Bloomberg High Yield Bond ETF (since Dec 2007)
// - LQD: iShares iBoxx $ Investment Grade Corporate Bond ETF (since Jul 2002)
// - TLT: iShares 20 Plus Year Treasury Bond ETF (since Jul 2002)
// - TLH: iShares 10-20 Year Treasury Bond ETF (since Jan 2007)
// - IEF: iShares 7-10 Year Treasury Bond ETF (since Jul 2002)
// - IEI: iShares 3-7 Year Treasury Bond ETF (since Jan 2007)
// - BIL: SPDR Bloomberg 1-3 Month T-Bill ETF (since May 2007)
// - TIP: iShares TIPS Bond ETF (since Dec 2003)

CHECK_STOCK_MARKET = IIf(StrToUpper(Name()) == "JNK", True, False);
IS_SAFE_ASSET = IIf(StrToUpper(Name()) == "TIP" || StrToUpper(Name()) == "BIL", True, False);

switch (StrToUpper(Name()))
{
	case "JNK": RAW_SCORE = 7; break;
	case "LQD": RAW_SCORE = 6; break;
	case "TLT": RAW_SCORE = 5; break;
	case "TLH": RAW_SCORE = 4; break;
	case "IEF": RAW_SCORE = 3; break;
	case "IEI": RAW_SCORE = 2; break;
	case "BIL": RAW_SCORE = 1; break;
	case "TIP": RAW_SCORE = 1; break;
	default: RAW_SCORE = 0; break;
```

```
}

//------------------------------------------------------------------------------
// backtester settings
// this strategy requires the following settings:
// - Positions: Long
// - Periodicy: Weekly
// - Pad and align all data to reference symbol: $SPX

SetOption("InitialEquity", 1e6);
SetOption("MarginRequirement", 100); // 100% == pay in full

SetOption("CommissionMode", 3); // mode 3 == $/share
SetOption("CommissionAmount", 0.01); // $0.01

SetTradeDelays(1, 1, 1, 1); // next day open
BuyPrice = SellPrice = ShortPrice = CoverPrice = Open;
SetOption("AllowSameBarExit", False);
SetOption("ActivateStopsImmediately", False);
SetOption("UsePrevBarEquityForPosSizing", True);
SetOption("AllowPositionShrinking" , True);

SetOption("MaxOpenPositions", BOND_NUM);
// FIXME: leaves 50% cash, if no bond (other than BIL or TIP) is investable
SetPositionSize( IIf(IS_SAFE_ASSET, 100, 100 / BOND_NUM), spsPercentOfEquity);
SetOption("MinPosValue", 0.01);
RoundLotSize = 1;

SetBacktestMode(backtestRotational);
SetOption("WorstRankHeld", 1);

SetOption("InterestRate", 0.0);
//SetOption("PortfolioReportMode", 1); // mode 1 == detailed log, mode 2 == summary

//------------------------------------------------------------------------------
// manage safe assets

if (IS_SAFE_ASSET)
{
	mom = LinRegSlope(log(Close), SAFE_PER);

	if (StrToUpper(Name()) == "TIP") safe2 = "BIL";
	else safe2 = "TIP";

	SetForeign(safe2);
		mom2 = LinRegSlope(log(Close), SAFE_PER);
	RestorePriceArrays();

	PositionScore = IIf(mom > mom2, RAW_SCORE, 0);
}

//------------------------------------------------------------------------------
// manage investment assets

else
{
	bondPriceRising = IIf(LinRegSlope(log(Close), BOND_PER) > 0, 1, 0);

	SetForeign("%TYX"); // long-term yield (fred:DGS20)
		ltYieldFalling = IIf(LinRegSlope(Close, YIELD_LT_PER) < 0, 1, 0);
	RestorePriceArrays();

	SetForeign("%IRX"); // short-term yield (fred:DTB3)
		stYieldFalling = IIf(LinRegSlope(Close, YIELD_ST_PER) < 0, 1, 0);
	RestorePriceArrays();
```

```
        SetForeign("$DJU"); // Dow Jones Utility Index
                utilityIdxRising = IIf(LinRegSlope(log(Close), UTILITY_IDX_PER) > 0, 1, 0);
        RestorePriceArrays();

        SetForeign("#PPISA"); // Producer Price Index (fred:PPIACO) or CRB Index
                commodityIdxFalling = IIf(LinRegSlope(log(Close), COMMODITY_IDX_PER) < 0, 1, 0);
        RestorePriceArrays();

        if (CHECK_STOCK_MARKET)
        {
                SetForeign("$SPXTR"); // S&P 500 Total Return Index
                        stockMarketHealthy = Iif(EMA(Close, SPX_FAST) > EMA(Close, SPX_SLOW), 0, -
100);
                RestorePriceArrays();
        }
        else
        {
                stockMarketHealthy = 0;
        }

        totalScore = bondPriceRising + stockMarketHealthy
                + ltYieldFalling + stYieldFalling
                + utilityIdxRising + commodityIdxFalling;

        PositionScore = IIf(totalScore >= 3, RAW_SCORE, 0);
}

//================================================================================
// end of file
```