**Portfolio back testing**

1. Select all ETFs from Betterment provided in this list <https://robo4me.sharepoint.com/:x:/s/RoboAdvisor/EcKWshykSKdCjsM7-SCUTFABSBQ8cAnvR-xYyPZnga9QnQ?e=e3VbhH>
2. Betterment starts all return series from January 2000
   1. Take the first 5 years for training the model and the rest for testing –Check for consistency
3. Include costs into the portfolio (expense ratio)
4. Create 11 portfolio with equity exposure (bonds and stocks from 0% to 100%)
5. Run the optimization on all portfolios every Friday from the beginning of the fifth year of the data
   1. When running ongoing optimization on weekly basis portfolios should not exceed +-2% from the initial allocation strategy on each portfolio – every week (probably end of the week)
6. Record the results
   1. Record daily return for the duration of the test
   2. Record daily volatility
   3. Record weekly moving average of each portfolio
   4. Record the holdings changes of each portfolio
7. Check if the portfolio has winning stocks in its final portfolio
8. Compare portfolio with and index and other platforms portfolios (we will find this from other platform for now only compare with an index)
9. Compare results with Portfolio Visualizer
10. Document and PRESENT the result and the process (also part of the regulatory requirements)

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| --- | --- | --- | --- | --- | --- |
| TAXABLE |  |  |  |  |  |
| **Asset Class** | **Ticker** | **ETF** | **Fund Name** | **Index** | **Expense Ratio** |
| **U.S. Total Stock Market** | Primary | VTI | [Vanguard Total Stock Market ETF](https://investor.vanguard.com/etf/profile/VTI) | CRSP U.S. Total Market | 0.03% |
| Alternate | ITOT | [iShares Core S&P Total U.S. Stock Mkt ETF](https://www.ishares.com/us/products/239724/ishares-core-sp-total-us-stock-market-etf) | Dow Jones U.S. Broad Stock Market | 0.03% |
| **U.S. Large-Cap Value Stocks** | Primary | VTV | [Vanguard Value ETF](https://investor.vanguard.com/etf/profile/VTV) | CRSP U.S. Large Value | 0.04% |
| Alternate | SPYV | [SPDR® Portfolio S&P 500 Value ETF](https://www.ssga.com/us/en/individual/etfs/funds/spdr-portfolio-sp-500-value-etf-spyv) | S&P 500 Value | 0.04% |
| **U.S. Mid-Cap Value Stocks** | Primary | VOE | [Vanguard Mid-Cap Value ETF](https://investor.vanguard.com/etf/profile/VOE) | CRSP U.S. Mid Value | 0.07% |
| Alternate | IWS | [iShares Russell Mid-Cap Value ETF](https://www.ishares.com/us/products/239719/ishares-russell-midcap-value-etf) | Russell Midcap Value | 0.24% |
| **U.S. Small-Cap Value Stocks** | Primary | VBR | [Vanguard Small-Cap Value ETF](https://investor.vanguard.com/etf/profile/VBR) | CRSP U.S. Small Value | 0.07% |
| Alternate | IWN | [iShares Russell 2000 Value ETF](https://www.ishares.com/us/products/239712/ishares-russell-2000-value-etf) | Russell 2000 Value | 0.24% |
| **International Developed Stocks** | Primary | VEA | [Vanguard FTSE Developed Markets ETF](https://investor.vanguard.com/etf/profile/VEA) | FTSE Developed ex U.S. All Cap Net Tax (U.S. RIC) Index | 0.05% |
| Alternate | IEFA | [iShares Core MSCI EAFE ETF](https://www.ishares.com/us/products/244049/ishares-core-msci-eafe-etf) | MSCI EAFE IMI | 0.07% |
| **Emerging Market Stocks** | Primary | VWO | [Vanguard FTSE Emerging Markets ETF](https://investor.vanguard.com/etf/profile/VWO) | FTSE Custom Emerging Markets All Cap China A Inclusion Net Tax (U.S. RIC) Index | 0.10% |
| Alternate | IEMG | [iShares Core MSCI Emerging Markets ETF](https://www.ishares.com/us/products/244050/ishares-core-msci-emerging-markets-etf) | MSCI EM (Emerging Markets) IMI | 0.11% |
| **Short-Term Treasuries** | Primary | GBIL | [Goldman Sachs Access Treasury 0-1 Year ETF](https://www.gsam.com/content/gsam/us/en/individual/products/etf-fund-finder/goldman-sachs-access-treasury-0-1-year-etf.html) | FTSE US Treasury 0-1 Year Composite Select Index | 0.12% |
| **U.S. Short-Term Bonds** | Primary | JPST | [JPMorgan Ultra-Short Income ETF](https://am.jpmorgan.com/us/en/asset-management/gim/adv/products/d/jpmorgan-ultra-short-income-etf-etf-shares-46641q837#/performance) | N.A. | 0.18% |
| **Inflation Protected Bonds** | Primary | VTIP | [Vanguard Short-Term Infl-Prot Secs ETF](https://investor.vanguard.com/etf/profile/VTIP) | Bloomberg Barclays U.S. Treasury TIPS (0-5 Y) | 0.05% |
| **U.S. Municipal Bonds** | Primary | MUB | [iShares National Muni Bond ETF](https://www.ishares.com/us/products/239766/ishares-national-amtfree-muni-bond-etf) | S&P National AMT-Free Municipal Bond | 0.07% |
| Alternate | TFI | [SPDR® Nuveen Blmbg Barclays Muni Bd ETF](https://www.ssga.com/us/en/individual/etfs/funds/spdr-nuveen-bloomberg-barclays-municipal-bond-etf-tfi) | Bloomberg Barclays Municipal Managed Money 1-25 Years Index | 0.23% |
| **U.S. High Quality Bonds** | Primary | AGG | [iShares Core U.S. Aggregate Bond ETF](https://www.ishares.com/us/products/239458/ishares-core-total-us-bond-market-etf) | Bloomberg Barclays U.S. Aggregate | 0.04% |
| **International Developed Bonds** | Primary | BNDX | [Vanguard Total International Bond ETF](https://investor.vanguard.com/etf/profile/BNDX) | Bloomberg Barclays Global Aggregate x USD Float Adjusted RIC Capped | 0.08% |
| **Emerging Market Bonds** | Primary | EMB | [iShares JP Morgan USD Em Mkts Bd ETF](https://www.ishares.com/us/products/239572/ishares-jp-morgan-usd-emerging-markets-bond-etf) | JP Morgan EMBI Global Core Index | 0.39% |
| **Alternate** | VWOB | [Vanguard Emerging Mkts Govt Bd ETF](https://investor.vanguard.com/etf/profile/VWOB) | Bloomberg Barclays USD Emerging Markets Government RIC Capped Bond | 0.25% |
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| Account Type: IRA |  |  |  |  |  |
| **Asset Class** | **Ticker** | **ETF** | **Fund Name** | **Index** | **Expense Ratio** |
| **U.S. Total Stock Market** | Primary | VTI | [Vanguard Total Stock Market ETF](https://investor.vanguard.com/etf/profile/VTI) | CRSP U.S. Total Market | 0.03% |
| Alternate | SCHB | [Schwab US Broad Market ETF™](https://www.schwabfunds.com/public/csim/home/products/exchange_traded_funds/summary.html?symbol=SCHB) | S&P TMI | 0.03% |
| **U.S. Large-Cap Value Stocks** | Primary | VTV | [Vanguard Value ETF](https://investor.vanguard.com/etf/profile/VTV) | CRSP U.S. Large Value | 0.04% |
| Alternate | SCHV | [Schwab US Large-Cap Value ETF™](https://www.schwabfunds.com/public/csim/home/products/exchange_traded_funds/summary.html?symbol=SCHV) | Dow Jones U.S. Total Stock Market Large-Cap Value | 0.04% |
| **U.S. Mid-Cap Value Stocks** | Primary | VOE | [Vanguard Mid-Cap Value ETF](https://investor.vanguard.com/etf/profile/VOE) | CRSP U.S. Mid Value | 0.07% |
| Alternate | IJJ | [iShares S&P Mid-Cap 400 Value ETF](https://www.ishares.com/us/products/239764/ishares-sp-midcap-400-value-etf) | S&P Mid Cap 400 Value | 0.18% |
| **U.S. Small-Cap Value Stocks** | Primary | VBR | [Vanguard Small-Cap Value ETF](https://investor.vanguard.com/etf/profile/VBR) | CRSP U.S. Small Value | 0.07% |
| Alternate | SLYV | [SPDR® S&P 600 Small Cap Value ETF](https://www.ssga.com/us/en/individual/etfs/funds/spdr-sp-600-small-cap-value-etf-slyv) | S&P Small Cap 600 Value | 0.15% |
| **International Developed Stocks** | Primary | VEA | [Vanguard FTSE Developed Markets ETF](https://investor.vanguard.com/etf/profile/VEA) | FTSE Developed ex U.S. All Cap Net Tax (U.S. RIC) Index | 0.05% |
| Alternate | SCHF | [Schwab International Equity ETF™](https://www.schwabfunds.com/public/csim/home/products/exchange_traded_funds/summary.html?symbol=SCHF) | FTSE Developed ex US Index | 0.06% |
| **Emerging Market Stocks** | Primary | VWO | [Vanguard FTSE Emerging Markets ETF](https://investor.vanguard.com/etf/profile/VWO) | FTSE Custom Emerging Markets All Cap China A Inclusion Net Tax (U.S. RIC) Index | 0.10% |
| Alternate | SPEM | [SPDR® S&P Emerging Markets ETF](https://www.ssga.com/us/en/individual/etfs/funds/spdr-portfolio-emerging-markets-etf-spem) | S&P Emerging Markets BMI | 0.11% |
| **Short-Term Treasuries** | Primary | GBIL | [Goldman Sachs Access Treasury 0-1 Year ETF](https://www.gsam.com/content/gsam/us/en/individual/products/etf-fund-finder/goldman-sachs-access-treasury-0-1-year-etf.html) | FTSE US Treasury 0-1 Year Composite Select Index | 0.12% |
| **U.S. Short-Term Bonds** | Primary | JPST | [JPMorgan Ultra-Short Income ETF](https://am.jpmorgan.com/us/en/asset-management/gim/adv/products/d/jpmorgan-ultra-short-income-etf-etf-shares-46641q837) | N.A. | 0.18% |
| **Inflation Protected Bonds** | Primary | VTIP | [Vanguard Short-Term Infl-Prot Secs ETF](https://investor.vanguard.com/etf/profile/VTIP) | Bloomberg Barclays U.S. Treasury TIPS (0-5 Y) | 0.05% |
| **U.S. High Quality Bonds** | Primary | AGG | [iShares Core U.S. Aggregate Bond ETF](https://www.ishares.com/us/products/239458/ishares-core-total-us-bond-market-etf) | Bloomberg Barclays U.S. Aggregate | 0.04% |
| **International Developed Bonds** | Primary | BNDX | [Vanguard Total International Bond ETF](https://investor.vanguard.com/etf/profile/BNDX) | Bloomberg Barclays Global Aggregate x USD Float Adjusted RIC Capped | 0.08% |
| **Emerging Market Bonds** | Primary | EMB | [iShares JP Morgan USD Em Mkts Bd ETF](https://www.ishares.com/us/products/239572/ishares-jp-morgan-usd-emerging-markets-bond-etf) | JP Morgan EMBI Global Core Index | 0.39% |
| Alternate | PCY | [PowerShares Emerging Markets Sov Dbt ETF](https://www.invesco.com/us/financial-products/etfs/product-detail?ticker=PCY) | DB Emerging Market USD Liquid Balanced Index | 0.50% |
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