Portfolio Management for Insurers and Pension Funds and COVID-19: Targeting Volatility for Equity, Balanced and Target-Date Funds with Leverage Constraints

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Coverage

- Background: Why target volatility? Importance of leverage constraints and market crashes.
- Forecasting Volatility and Constructing Portfolios.
- Results: Equity, Balanced and Target-date Funds with constraints on leverage.
- Results: Equity Portfolios for Crisis Periods and Post Crisis, including COVID-19 Crisis (to be covered in IPRA Special Session on 14 December, 2020)
- Summary and Conclusions.

Why Target Volatility?

- Targeting (constant) equity exposure to manage risk assumes constant volatility. Volatility is volatile, targeting volatility is required for constant risk (volatility).
- Theoretical and empirical studies support negative correlation between equity market returns and conditional volatility.
- Recent research demonstrates enhanced returns as well as downside risk reduction from target volatility strategies for equity funds.
- Low interest rates and increased volatility following the Global Credit Crisis highlight importance of enhanced return and downside risk strategies.
- Insurers with variable annuity portfolios, superannuation/pension funds with balanced and target-date funds and alternative investment funds can benefit from targeted constant volatility strategies.

Volatility Feedback

- Volatility feedback and leverage effect:
  - higher (lower) volatility produces a stock market price fall (rise) as the required rate of return on the stock market increases (decreases).(see [Poterba and Summers, 1986], [Campbell and Hentschel, 1992], [Bekaert and Wu, 2000], [Wu, 2001] and [Bollerslev et al., 2006].)
- Demonstrated negative empirical relationship between equity market returns and conditional volatility ([Hocquard et al., 2013], [Moreira and Muir, 2017] and [Doan et al., 2018]).

Volatility Timing Strategies

- Volatility timing strategies typically multivariate and involve forecasting variance-covariance matrix of returns for assets in the portfolio ([Fleming et al., 2001, Fleming et al., 2003], [Han, 2006], [Liu, 2009], [Kirby and Ostdiek, 2012] and [Clements and Silvennoinen, 2013].)
- [Doan et al., 2018] developed a univariate volatility timing strategy and demonstrated substantial improvement in equity return performance, even after allowing for transaction costs - 100 to 350 basis points above the stock index return, and significantly reduced exposure to downside risk from stock market crashes.
- [Moreira and Muir, 2017], consider volatility timing using variance rather than volatility and also find strategies that outperform on a risk adjusted basis.

Target Volatility - Implementation

- Forecasts of market return volatility at the daily level.
- Forecasting approach - an outlier corrected GARCH(1,1) model estimated on daily returns, winsorizing extreme returns before model estimation ([Gregory and Reeves, 2002, Gregory and Reeves, 2010], [Carnero et al., 2007, Carnero et al., 2012], and [Harvey, 2013]).
- Volatility forecasts are used to adjust market exposure to target a constant market volatility - higher volatility forecasts result in reduced market exposure, while lower volatility forecasts result in increased market exposure.
- Adjustments made using stock index futures contracts overlays, results in very small portfolio transaction costs.

Target Volatility - Implementation

- We assess equity portfolios, balanced portfolios (with 65% in equity and 35% in bonds) and target-date portfolios.
- Target-date portfolios for a range of time periods and three glide paths of declining equity exposure are examined; aggressive, moderate and conservative.
- Different leverage constraints are examined; conservative, moderate and aggressive.
- Results are for the U.S. as it has the largest market of equity, balanced and target-date funds.

Target Volatility - Results Summary

- Equity portfolios show outperformance for constant volatility portfolios.
- Return per unit of risk is relatively constant with respect to leverage constraints.
- Results extend to balanced portfolios with equity and bond allocations, that have higher return per unit of risk.
- Outperformance for constant volatility target-date portfolios with leverage constraints - aggressive leverage leads to higher average investment outcomes with higher variability.
- Target volatility strategies mitigate downside risk from market crashes including COVID-19.

Volatility Forecasting

- The weighted daily equity return (in percentage) at date t is given by;

$$r_t = \varepsilon_t, \tag{1}$$

where r_t is winsorized at $\pm 4\%$, ε_t is i.i.d $(0, \sigma_t^2)$, and the conditional variance σ_t^2 follows the GARCH(1,1) process;

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \sigma_{t-1}^2 \tag{2}$$

with the following parameter constraints $\alpha_0 > 0$, $\alpha_1 \geq 0$, $\alpha_2 \geq 0$ and $\alpha_1 + \alpha_2 < 1$.

- The starting values for $\hat{\varepsilon}_0^2$ and $\hat{\sigma}_0^2$ are the unconditional sample variance.
- Given the estimated parameter set $\{\hat{\alpha}_0, \hat{\alpha}_1, \hat{\alpha}_2\}$ for each estimation window of 1,000 observations, we compute the one-day ahead volatility forecast using the following equation;

$$\hat{\sigma}_{t+1}^2 = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{\varepsilon}_t^2 + \hat{\alpha}_2 \hat{\sigma}_t^2 \tag{3}$$

Portfolio Returns

- The daily returns of equity and bond components on day t are given by $r_{equity,t}$ and $r_{bond,t}$, respectively.
- Daily return at date t of the trading strategy on equity portfolio is computed as;

$$r_{equity,t} = (w_t - 1)r_{futures,t} + r_{market,t} \tag{4}$$

  where $r_{futures,t}$ is the index futures return at date t.
- For the balanced portfolio, the daily returns at day t of the trading strategy are computed as;

$$r_{balanced,t} = 0.65r_{equity,t} + 0.35r_{bond,t} \tag{5}$$

  where $r_{bond,t}$ is the daily bond return at date t.

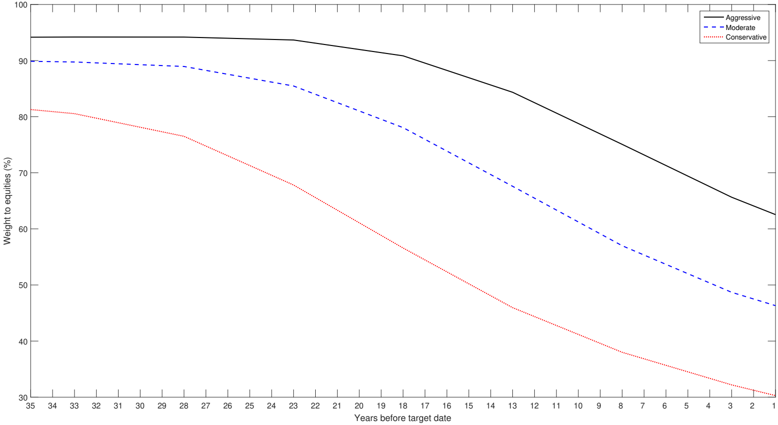
Portfolio construction - Equity and Balanced Portfolios

- Daily participation ratio is the weight w_t invested in the market equity portfolio:
$$w_t = \frac{target\ \ volatility}{\hat{\sigma}_t}, \tag{6}$$
where $\hat{\sigma}_t$ is the volatility forecast for trading day t.
- When forecast volatility for a given trading day is greater (lesser) than target volatility, we sell (buy) futures contracts on the equity market, leading to a decrease (increase) in portfolio volatility.
- Threshold weight change (δ), used to minimize excessive turnover, only change market exposure when new participation ratio differs from the previous by an absolute amount greater than δ.
- In leveraging the equity portfolio, we set different levels of maximum participation ratio, namely 1, 1.5, 2, and unrestricted value.

Portfolio construction - Target Date Portfolios

- For target-date portfolio, we assume:
  - contributions of 9% of salary at the end of each year.
  - initial annual wage 20,000 USD, which grows by 4% in nominal terms every year.
  - target-date fund equity contributions are reset at the end of each year, without considering tax implications or transaction costs.
- Glide path of the target-date fund, reflects asset allocation for aggressive, moderate, and conservative strategies from the Morningstar Lifetime Allocation Indexes as of June 2017.
- We focus on equity and bond investment and aggregate non-equity securities into the bond asset class.

Figure: **Equity contribution to target-date portfolio**



Data - Equity, Futures

- US market index returns are value-weighted market returns from the KenFrench website from May 1978 to June 2020 (data to April 1982 used to initialize volatility forecasting model).
- The series is adjusted to account for dividend re-investment.
- The same data over January 1926 to 1932 is used to study the performance of target volatility portfolio over the Great Depression.
- Daily settlement price series of futures contracts on the S&P500 from Datastream. The daily returns of futures contracts start in April 1982.
- Bond data are the US bond return index that includes a wide set of government and corporate bonds, provided by Barclays (mnemonic: LHAGGBD). The bond returns start at the same time as equity returns.
- The statistics include the annualized average return in percentage (μ), annualized standard deviation in percentage (σ), return per unit of risk (ϕ), and maximum daily drawdown (Min ret).

Equity Portfolios

Equity portfolio performance statistics with $\delta = 0.1$

	μ	σ	ϕ	Min ret
Market portfolio	11.59	17.70	0.65	-17.41
Maximum participation ratio of 1				
Daily market volatility 0.8%	10.12	12.49	0.81	-9.03
Daily market volatility 1.0%	10.60	13.93	0.76	-14.09
Daily market volatility 1.2%	10.82	14.90	0.73	-17.41
Maximum participation ratio of 1.5				
Daily market volatility 0.8%	11.25	13.81	0.81	-9.03
Daily market volatility 1.0%	12.60	16.64	0.76	-14.09
Daily market volatility 1.2%	13.53	18.84	0.72	-19.15
Maximum participation ratio of 2				
Daily market volatility 0.8%	11.45	13.98	0.82	-9.03
Daily market volatility 1.0%	13.29	17.39	0.76	-14.09
Daily market volatility 1.2%	14.61	20.60	0.71	-19.15
Unrestricted participation ratio				
Daily market volatility 0.8%	11.47	13.99	0.82	-9.03
Daily market volatility 1.0%	13.53	17.51	0.77	-14.09
Daily market volatility 1.2%	15.33	21.19	0.72	-19.15

Equity Portfolios - Comments

- Return per unit risk remains approximately the same as the leverage (maximum participation ratio) increases for any given target market volatility.
- Target of daily volatility of 1% (15.9% *p.a.*) produces higher return for higher maximum participation ratios and limits downside.
- Maximum participation ratio of 1.5 with daily target volatility of 1.0% has 1% *p.a.* higher return with slightly lower volatility compared to the market portfolio.
- Maximum participation ratio of 1.0 lowers return and volatility compared with no volatility targeting but with the same return per unit of risk as for higher leverage ratios.
- Lower (higher) target daily volatility has lower (higher) maximum draw-down (minimum return).

Balanced Portfolios

Balanced portfolio performance statistics with $\delta = 0.1$

	μ	σ	ϕ	Min ret
Balanced portfolio	11.94	11.74	1.02	-11.32
Maximum participation ratio of 1				
Daily market volatility 0.8%	10.76	8.54	1.26	-5.87
Daily market volatility 1.0%	11.13	9.41	1.18	-9.16
Daily market volatility 1.2%	11.31	10.00	1.13	-11.32
Maximum participation ratio of 1.5				
Daily market volatility 0.8%	11.55	9.38	1.23	-5.87
Daily market volatility 1.0%	12.53	11.14	1.13	-9.16
Daily market volatility 1.2%	13.24	12.52	1.06	-12.45
Maximum participation ratio of 2				
Daily market volatility 0.8%	11.68	9.49	1.23	-5.87
Daily market volatility 1.0%	13.02	11.62	1.12	-9.16
Daily market volatility 1.2%	14.03	13.65	1.03	-12.45
Unrestricted participation ratio				
Daily market volatility 0.8%	11.69	9.49	1.23	-5.87
Daily market volatility 1.0%	13.18	11.70	1.13	-9.16
Daily market volatility 1.2%	14.53	14.04	1.03	-12.45

Balanced Portfolios - Comments

- Inclusion of bonds increases return and reduces volatility compared to the equity only portfolio.
- Return per unit risk is higher than for balanced fund without target volatility reflecting the impact of the bond portfolio.
- Lower target volatility has higher return per unit risk.
- Daily target volatility of 1% p.a. similar volatility to balanced portfolio without volatility target with higher expected return - for maximum participation ratio of 1.5 an additional return of over 0.5% p.a.

Target Date Portfolio - 35-year target date fund performance statistics

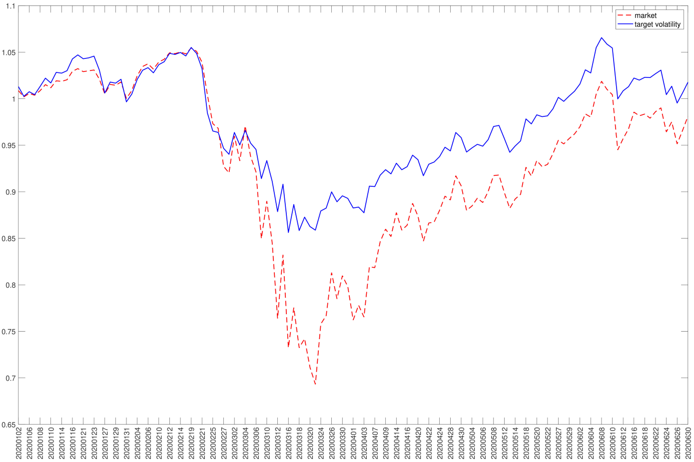
	Aggressive	Moderate	Conservative
	Panel A: No volatility targeting		
Mean	692,538 (9.78%)	641,232 (9.39%)	581,898 (8.91%)
Stdev	37,026	36,802	37,381
Min	525,889	509,902	480,159
Max	769,065	741,362	690,985
	Panel B: Volatility targeting		
	Maximum participation ratio of 1		
Mean	612,227 (9.16%)	569,872 (8.80%)	526,205 (8.39%)
Stdev	26,821	27,953	30,606
Min	529,929	496,744	461,361
Max	669,031	627,678	595,134
	Maximum participation ratio of 1.5		
Mean	809,166 (10.54%)	736,941 (10.08%)	652,772 (9.48%)
Stdev	46,136	46,145	46,171
Min	672,816	616,689	551,781
Max	921,491	828,204	750,074
	Maximum participation ratio of 2		
Mean	862,591 (10.85%)	784,743 (10.39%)	690,271 (9.76%)
Stdev	51,736	50,963	49,731
Min	714,500	653,406	580,773
Max	996,136	892,569	793,326

Target Date Portfolios - Comments

- For 35 year target date fund, volatility targeting with a maximum participation ratio of 1.5 enhances annual returns by approximately 0.6%*p.a.* for conservative glide path and approximately 0.7%*p.a.* for moderate and aggressive glide paths.
- For 25 year target date fund, volatility targeting with a maximum participation ratio of 1.5 enhances annual returns by approximately 0.5%*p.a.* for conservative glide path, approximately 0.65%*p.a.* for moderate glide path and approximately 0.75%*p.a.* for aggressive glide paths.
- Volatility targeting with a maximum participation ratio of 1 reduces accumulations compared to no volatility targeting.

Equity portfolios over the COVID-19 pandemic

US January to June 2020 (coverage on market crashes including COVID-19 in IPRA Session).



Concluding remarks

- Target volatility strategies have theoretical and empirical support - effective forecasting of volatility to increase or decrease equity exposures enhances return and limits downside.
- Strategies are readily applied for equity only portfolios, balanced portfolios and target date portfolios and are relevant for insurers with variable annuities, pensions funds offering balanced funds and target date funds, or for a return enhanced alternative investments fund.
- Leverage does not impact significantly the higher return per unit risk provided by target volatility strategies, nor the maximum draw-down (minimum return).
- Target volatility strategies enhance return and limit downside for a range of major market crashes in US including the recent COVID-19 Crisis.

Questions and Discussion

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Questions and Discussion

Insurance: Mathematics and Economics Paper
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Original Working Paper
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2614828

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