

2012

A new rebalancing methodology to reduce risk and increase dollar cost averaging in Defined Contribution Plans

Examining the hypothesis that increased rebalancing frequency through the use of cash flows will result in enhanced risk mitigation and dollar cost averaging.



Summary of findings

This study was conducted over a three year period to determine whether or not the frequency of portfolio rebalancing in defined contribution plans had an effect on risk mitigation. A professionally constructed model portfolio designed to exist on the efficient frontier was used and it was hypothesized that the higher the frequency of rebalancing the greater the degree of risk mitigation.

As methods of rebalancing have two primary components, cash flow management (plan contributions) and rebalance frequency; the traditional methods studied use plan contributions as passively invested based on an originally designed asset allocation, followed by rebalancing (highest to lowest) at either quarterly, semi-annual or annual intervals.

These three methods were compared to a fourth method, that of the **Self-Aligning Portfolios™** (U.S. Pat. 8,060,428) developed by **Invest n Retire, LLC (INR)**; which uses cash flows at each payroll period to bring a portfolio either wholly or partially back into balance followed by a quarterly rebalance as necessary. This fourth method served as the highest frequency rebalancing method considered.

The data strongly supported the hypothesis, that the higher the rebalancing frequency, the higher the degree of risk mitigation (evidenced through higher returns and fewer losses when compared to traditional passive cash flow management and reduced rebalancing frequencies).

Furthermore, at the conclusion of the study, Self-Aligning Portfolios™ generated larger asset positions than comparative methods; the result of using cash flows at each contribution period to purchase more shares of underweighted positions and either few or no shares in over weighted positions.

Introduction

In 1952 **Harry Markowitz** introduced **Modern Portfolio Theory**, which uses asset allocation to maximize returns from a portfolio exposed to a specific risk level. A portfolio which achieves this objective is said to exist at the ideal (tangency) position of the **efficient frontier**.

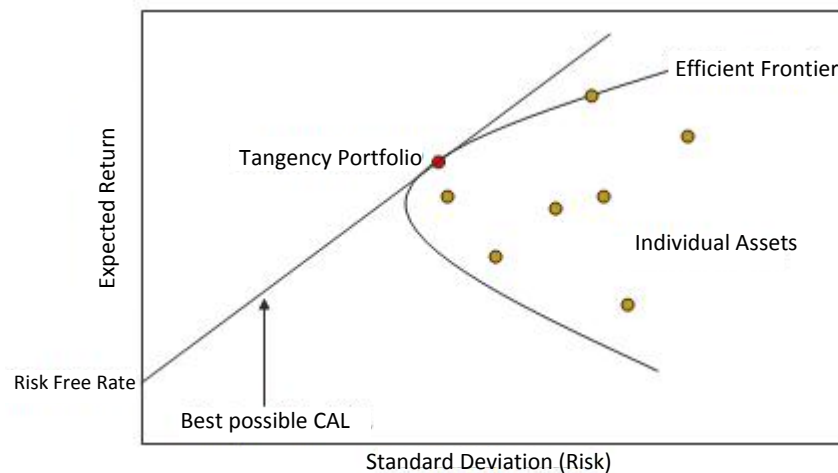


Figure 1: The Markowitz Bullet

In the example above, the red dot represents a portfolio that is ideally situated on the efficient frontier. The portfolio is the sum total of all the yellow dots, which represent the particular investments contained in the portfolio and their respective weightings.

This hypothetical efficient portfolio can easily depart from its ideal position on the efficient frontier. Over time, market forces may impact the weightings of positions within the portfolio, causing it to move to a position of moderately higher return exposure accompanied by substantially increased risk exposure (*Fig. 2 Point A*) or vice versa (*Fig. 2 Point B*), moderately lower risk exposure with substantially reduced return potential.

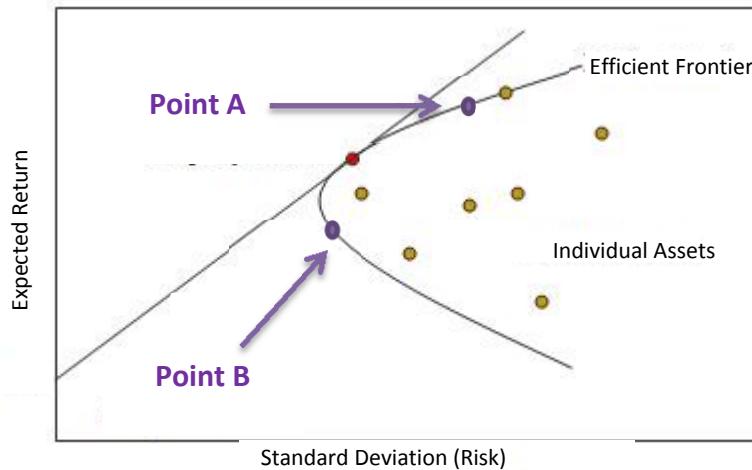


Figure 2: Departure of a portfolio from its ideal position on the efficient frontier

These market forces can be magnified, to some extent, by the traditional method of investing cash flows, which divide up plan contributions and invest them solely on the initial design of the portfolio. This further drives the portfolio away from its initial (efficient) design and introduces the necessity of periodic rebalancing.

Traditionally, these two combined forces (market and cash flow) are responsible for moving a portfolio away from its ideal position on the efficient frontier; as both produce a negative effect under the tenets of Modern Portfolio Theory. Yet, of these two forces, only market forces are beyond control, while cash flow forces are not.

This study hypothesizes that by using cash flows; such as regular payroll contributions, as a mechanism to increase portfolio rebalance frequency will effectively reduce a portfolio's movement away from its ideal position on the efficient frontier and hence, mitigate its risk as a result of the increased rebalancing frequency. This method, developed by Invest n Retire®, is known as Self-Aligning Portfolios™ (SAP).

Further, by using cash flows for rebalancing purposes through SAP, more shares in underweighted positions are purchased and either few or no shares of overweighted positions are purchased; resulting in greater dollar cost averaging effect when compared to traditional cash flow management and rebalancing methods (quarterly, semi-annually, and annually).

Data from an actual retirement plan participant was used over the study's 3 year period, which extended from 2009 to 2011.

Traditional methods of cash flow use and rebalancing

Keeping a portfolio in line with its intended design is important, that is why rebalancing occurs in nearly every type of investment portfolio.

In a defined contribution plan, when an employee contributes money to his or her retirement account, there is an event where cash flows into the account. The typical method for investing cash flows is to follow the asset allocation design, ignoring the value of the assets within the portfolio.

For example, let's say you enroll in your company's retirement plan on January 1. Hypothetically, your model portfolio is built with specific risk/reward characteristics, so your money is allocated across two funds, Fund A and Fund B, each receiving 50% of the money you put into your account, \$100 each payroll period. Your first contribution to your account looks like this:

Date	Fund A		Fund B	
	Value	Percentage of Portfolio	Value	Percentage of Portfolio
January 1 st	+\$50	50%	+\$50	50%

Figure 3: Initial Balance

Hypothetically, between January 1 and January 15 the value of Fund A tripled. The effect of these market conditions causes your portfolio to become out-of-alignment with its original risk / reward, with a value of 75% in Fund A and 25% in Fund B as illustrated below.

Date	Fund A		Fund B	
	Value	Percentage of Portfolio	Value	Percentage of Portfolio
January 1 st	\$50	50%	\$50	50%
Change in Value	+\$100			
New Balance	\$150	75%	\$50	25%

Figure 4: Changing values as a result of market conditions between Jan. 1 and Jan. 15

If the traditional method of using cash flows is followed when you make another \$100 contribution on Jan 15, your money will be split 50/50 with an ending value in Fund A of \$200 or 67% and Fund B \$100 or 33% as illustrated below:

Date	Fund A		Fund B	
	Value	Percentage of Portfolio	Value	Percentage of Portfolio
January 1 st	\$50	50%	\$50	50%
Change in Value	+\$100		\$0	0%
January 15 th	+\$50		+\$50	
New Balance	\$200	67%	\$100	33%

Figure 5: January 15 payroll contribution effect

Although the portfolio design is intended to limit exposure to Fund A and Fund B to 50% each, market forces and additional contributions to the account places the portfolio in a position of being inconsistent with its risk reward characteristics (off of its optimal position on the efficient frontier). For this reason, rebalancing is necessary and typically occurs at intervals of quarterly, semi-annually or annually.

The Concept of Self-Aligning Portfolios™

Taking the same example and using the fourth method of using cash flows, Self-Aligning Portfolios™, your assets would first be valued in order to determine how to use your additional contribution (cash) in order to more closely maintain your intended asset allocation design.

Date	Fund A		Fund B	
	Value	Percentage of Portfolio	Value	Percentage of Portfolio
January 1 st	\$50	50%	\$50	50%
Change in Value	+\$100		\$0	
New Balance	\$150	75%	\$50	25%

Figure 6: Changing values as a result of market conditions between Jan. 1 and Jan. 15

SAP intelligently allocates your contribution by **first** valuing the portfolio and **then** determining how the money should be allocated to bring the portfolio back to or as close to being balanced as possible. Rather than splitting the contribution up 50/50 and continuing to allow the portfolio to further drift out-of-balance with its intended risk / reward characteristics, the portfolio is **first** valued, which shows that Fund A has tripled. In order to more closely follow the intended risk / reward design, this method determines that the entire contribution of \$100 should be invested in Fund B.

Date	Fund A		Fund B	
	Value	Percentage of Portfolio	Value	Percentage of Portfolio
January 1 st	\$50	50%	\$50	50%
Change in Value	+\$100		\$0	0%
January 15 th	\$0		+\$100	
New Balance	\$150	50%	\$150	50%

Figure 7: January 15th payroll contribution effect using Self-Aligning Portfolios™

Data basis for the study

A retirement plan participant was selected at random from a plan on the Invest n Retire® platform. The only qualification for consideration was that the participant had been enrolled in the plan for more than three years. The participant’s information was then used for the study, including:

- Starting balance
- Asset allocation
- Contribution dates
- Contribution amounts
 - o Pretax
 - o Match
 - o Catch-up
- Trade execution prices
- Rebalancing dates
- Dividend rates
- Dividend dates
- Plan expenses
- Investment changes

As the participant was enrolled in a plan using the SAP method for allocating cash flows, this information served as an independent variable. The dependent variables are the comparative outcomes resulting from the replication of the participant’s information under typical methods for rebalancing, which occur at intervals of quarterly, semi-annually and annually.

As trades using the SAP method occur intra-day, the execution prices also served as the execution prices for the comparative methods, collectively referred to as Hypothetical Rebalancing Methods (HRMs). If a trade did not occur for a security under the SAP method, the execution price for the HRM’s was taken from end-of-day Net Asset Value (NAV) pricing supplied by Morningstar™.

An example of this difference can be seen below when comparing the SAP portfolio, during at a contribution period, to a quarterly HRM at the same period (note that no purchases are made in SAP to positions valued and deemed to be over weighted- AGG, DFEMX, DISVX and DFSVX):

Self-Aligning Portfolios™						HRM Portfolio					
1/13/2009						1/13/2009					
		Contribution		Expenses				Contribution		Expenses	
		Pretax	\$ 762.22	RK	\$ -			Pretax	\$ 762.22	RK	\$ -
		Match	\$ 153.98	Custodian				Match	\$ 153.98	Custodian	
		Catchup	\$ 208.33	Advisor	\$ -			Catchup	\$ 208.33	Advisor	\$ -
	Source	Initial	Amount	Shares	Price		Source	Initial	Amount	Shares	Price
CASH	Pretax	\$ 1,281.78	\$ 0.45	0.450	\$ 1.00	CASH	Pretax	\$ 1,281.78	\$ 7.62	7.622	\$ 1.00
CASH	Match	\$ 215.51	\$ 0.12	0.120	\$ 1.00	CASH	Match	\$ 215.51	\$ 1.54	1.540	\$ 1.00
CASH	Catchup	\$ 148.63	\$ 0.10	0.100	\$ 1.00	CASH	Catchup	\$ 148.63	\$ 2.08	2.083	\$ 1.00
AGG	Pretax	\$ 4,332.87			\$ 103.22	AGG	Pretax	\$ 4,332.87	\$ 30.49	0.295	\$ 103.22
AGG	Match	\$ 554.91			\$ 103.22	AGG	Match	\$ 554.91	\$ 6.16	0.060	\$ 103.22
AGG	Catchup	\$ 354.35			\$ 103.22	AGG	Catchup	\$ 354.35	\$ 8.33	0.081	\$ 103.22
DFEMX	Pretax	\$ 5,102.68			\$ 15.84	DFEMX	Pretax	\$ 5,102.68	\$ 38.11	2.406	\$ 15.84
DFEMX	Match	\$ 749.28			\$ 15.84	DFEMX	Match	\$ 749.28	\$ 7.70	0.486	\$ 15.84
DFEMX	Catchup	\$ 519.39			\$ 15.84	DFEMX	Catchup	\$ 519.39	\$ 10.42	0.658	\$ 15.84
DISVX	Pretax	\$ 5,982.78			\$ 10.59	DISVX	Pretax	\$ 5,982.78	\$ 45.73	4.319	\$ 10.59
DISVX	Match	\$ 874.04			\$ 10.59	DISVX	Match	\$ 874.04	\$ 9.24	0.872	\$ 10.59
DISVX	Catchup	\$ 656.43			\$ 10.59	DISVX	Catchup	\$ 656.43	\$ 12.50	1.180	\$ 10.59
VGK	Pretax	\$ 20,887.87	\$ 171.33	4.646	\$ 36.88	VGK	Pretax	\$ 20,887.87	\$ 160.07	4.340	\$ 36.88
VGK	Match	\$ 3,086.38	\$ 34.63	0.939	\$ 36.88	VGK	Match	\$ 3,086.38	\$ 32.34	0.877	\$ 36.88
VGK	Catchup	\$ 2,104.24	\$ 46.83	1.270	\$ 36.88	VGK	Catchup	\$ 2,104.24	\$ 43.75	1.186	\$ 36.88
VTV	Pretax	\$ 19,445.91	\$ 351.45	8.864	\$ 39.65	VTV	Pretax	\$ 19,445.91	\$ 152.44	3.845	\$ 39.65
VTV	Match	\$ 2,822.80	\$ 70.96	1.790	\$ 39.65	VTV	Match	\$ 2,822.80	\$ 30.80	0.777	\$ 39.65
VTV	Catchup	\$ 2,099.15	\$ 96.06	2.423	\$ 39.65	VTV	Catchup	\$ 2,099.15	\$ 41.67	1.051	\$ 39.65
VUG	Pretax	\$ 23,781.38	\$ 43.63	1.120	\$ 38.96	VUG	Pretax	\$ 23,781.38	\$ 175.31	4.500	\$ 38.96
VUG	Match	\$ 3,256.98	\$ 8.80	0.226	\$ 38.96	VUG	Match	\$ 3,256.98	\$ 35.42	0.909	\$ 38.96
VUG	Catchup	\$ 1,878.81	\$ 11.92	0.306	\$ 38.96	VUG	Catchup	\$ 1,878.81	\$ 47.92	1.230	\$ 38.96
VO	Pretax	\$ 9,909.86	\$ 119.33	2.820	\$ 42.32	VO	Pretax	\$ 9,909.86	\$ 76.22	1.801	\$ 42.32
VO	Match	\$ 1,440.70	\$ 24.12	0.570	\$ 42.32	VO	Match	\$ 1,440.70	\$ 15.40	0.364	\$ 42.32
VO	Catchup	\$ 974.04	\$ 32.63	0.771	\$ 42.32	VO	Catchup	\$ 974.04	\$ 20.83	0.492	\$ 42.32
DFSVX	Pretax	\$ 3,903.13			\$ 14.05	DFSVX	Pretax	\$ 3,903.13	\$ 30.49	2.170	\$ 14.05
DFSVX	Match	\$ 583.31			\$ 14.05	DFSVX	Match	\$ 583.31	\$ 6.16	0.438	\$ 14.05
DFSVX	Catchup	\$ 485.01			\$ 14.05	DFSVX	Catchup	\$ 485.01	\$ 8.33	0.593	\$ 14.05
VBK	Pretax	\$ 6,003.80	\$ 76.03	1.857	\$ 40.95	VBK	Pretax	\$ 6,003.80	\$ 45.73	1.117	\$ 40.95
VBK	Match	\$ 839.07	\$ 15.35	0.375	\$ 40.95	VBK	Match	\$ 839.07	\$ 9.24	0.226	\$ 40.95
VBK	Catchup	\$ 538.08	\$ 20.79	0.508	\$ 40.95	VBK	Catchup	\$ 538.08	\$ 12.50	0.305	\$ 40.95
		\$124,813.17	\$1,124.53					\$124,813.17	\$1,124.53		

Figure 8: SAP Portfolio (left) compared to quarterly HRM portfolio (right)

116 events, similar to Figure 8 above, provided the data points for each rebalancing frequency, resulting in a total of over 464 points of measurement.

Dividend rates were also replicated, if an actual dividend was paid for a security under the SAP method, it was paid at the same rate for HRM’s. Additionally, as actual plan expenses occurred for the participant under the SAP method as a percentage of assets, the same rate was applied to account for plan expenses for the HRMs based on their asset levels.

During the 3 year study period, several investments were replaced and portfolio asset weightings adjusted. These instances include:

- 10/5/2009
Rebalance, BND replaces AGG, DISVX and VGK removed, portfolio weightings changed.
- 2/24/2010
VWO and VNQ added, portfolio weightings changed.

As the effects of these changes could be observed under the SAP method, they were implemented the same way for the HRMs; even if the change occurred away from a rebalancing event, it was assumed that if an investment was dropped from a plan and replaced by another, the assets would be mapped to the new investment.

Portfolio valuations were taken at the end of each month before dividends. In order to accurately compare the performance between the SAP method and the HRMs, given the frequency of these valuation periods, the **Modified Dietz Method** of performance reporting was used for comparative purposes.

Study Results

The 3 year study resulted in data which supported the hypothesis that using cash flows to more closely maintain portfolio alignment with the portfolio’s intended risk / reward characteristics mitigates risk and improves dollar cost averaging. Through its use of cash flows to increase rebalance frequency, the SAP method demonstrated an ability to mitigate risk at a higher degree than the comparative HRMs; evidenced through the SAP method’s achievement of higher returns (2009, 2010 and 36mo ROR) and fewer losses (2011) at each measure.

	2009 ROR	2010 ROR	2011 ROR	36 mo ROR
Self-Aligning	34.529%	15.945%	-5.906%	13.6430%
Quarterly	34.397%	15.673%	-5.949%	13.4995%
Semi Annual	34.325%	15.342%	-5.948%	13.3713%
Annual	34.188%	15.405%	-5.978%	13.3417%

Figure 9: Annual and total returns

By taking the total number of shares for each position in the SAP method and HRMs, then ascribing a weighting to each asset's total, proportionate to its weighting in the portfolio, the effect of increased dollar cost averaging as a function of rebalance frequency can be observed.

Asset	Self-Aligning	Quarterly	Semi Annual	Annual	Allocation
CASH	2673.89	2413.29	2406.20	3301.97	1%
BND	127.82	114.81	114.47	142.51	4%
VEU	2074.25	2068.63	2062.54	1934.28	32%
VWO	406.17	415.86	414.63	357.80	6%
VTV	942.42	927.89	925.15	950.86	18%
VUG	869.88	890.99	888.37	920.70	20%
VO	297.83	298.08	297.20	304.38	8%
VBK	181.98	188.28	187.72	179.92	5%
VBR	130.04	129.37	128.99	127.42	3%
VNQ	147.63	142.89	142.47	155.17	3%
Sum	7851.93	7590.08	7567.74	8375.03	
Weighted Total	1104.849993	1102.284269	1099.038089	1076.278535	
Percent Total	100.00%	99.77%	99.47%	97.41%	

Figure 10: Dollar cost averaging calculations presented by asset allocation weighting

Conclusion

Modern Portfolio Theory defines the nature of an efficient investment model; that which optimally balances risk and reward. Such a design occupies a particular position on the efficient frontier and any movement away from that position results in an increased risk, such as moderately higher return or loss potential accompanied by substantially increased risk exposure. This risk emerges over time due to market and cash flow forces. Mitigating this risk is accomplished through minimizing the degree of movement away from the portfolio's intended position on the efficient frontier.

This study hypothesized that increasing rebalancing frequency through the use of cash flows (SAP) would result in a greater degree of risk mitigation when compared to traditional rebalancing methods which do not use cash flows and, instead, rely exclusively on rebalancing at quarterly, semi-annual or annual intervals.

The data¹ supported the hypothesis that the SAP method successfully mitigated risk to a higher degree than the other three methods. Additionally, the SAP method resulted in a greater dollar cost averaging effect, evidenced through larger average share ownership at the end of the three year period. ‡

About the Author



Neil Plein is Vice President of Invest n Retire, LLC, a Portland, Ore. based record keeper specializing in offering ETFs to defined contribution plans through its patented technology for managing tax-deferred retirement accounts (patent U.S. 8,060,428).

Known for his objective work in the contemporary analysis of defined contribution plan technology, Neil is widely quoted as an expert source in *The Wall Street Journal*, *Investor's Business Daily*, *Bloomberg Businessweek*, *CNBC*, *PLANSPONSOR Magazine*, *Workforce Magazine* and other major industry-specific publications. He also writes for *ETF Guide*, where his articles are syndicated through *NASDAQ News*, *Yahoo! Finance* and other major web-based finance news sources. Additionally, he is a regularly featured guest on radio shows such as *The Index Investing Show* and the *Financial Impact Radio Factor*.

¹ To test this hypothesis, three years of actual participant data was used from a plan that used the SAP method. Over the three year study, there were 116 events which provided data points. These events were then replicated in rebalancing methods not using cash flows and only rebalanced at quarterly, semi-annual or annual intervals; resulting in 464 total points of measure between the four methods of cash flow use and rebalancing.