Risk Parity Approach : A Thematic Review of Literature and Research Opportunities

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Abstract

The crisis of 2008 diverted research energy towards exploring alternative asset allocation methods with the main focus on risk diversification of portfolio due to failure of traditional asset allocation strategies. Such alternative asset allocation methods, also called risk based approaches, have attracted significant research attention and risk parity approach is on the top. However, review of existing literature on risk parity approach remains mostly unattended for setting research priorities. Therefore, this study aimed to cover two aspects. First, it delineated over the historical development in financial literature, which led to the emergence of risk parity approach and second, it systematically and thematically reviewed the literature on risk parity approach over a last decade. The review found that majority of the studies have focused on empirical back testing of risk parity while recently, the theme such as portfolio robustness and methodology of constructing the risk parity portfolio has seen some limelight. Though risk parity is facing some key challenges like lack of clear investment objective and non-existence of complete theoretical model, further development looks promising as this review also shed light on future research opportunities in the risk parity domain.

Keywords: literature review, risk based approach, risk parity

JEL Classification : G10, G11, G15

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Financial literature has come a long way since the pioneering work done by Markowitz (1952, 1959). Alternative asset allocation methods named as risk-based approaches which focus on risk diversification of portfolio have attracted significant attention and interest from both academia and industry practitioners since 2008 crisis. Out of these risk based approaches, risk parity concept has seen significant research coverage. At the heart of the risk parity approach, also called equally weighted risk contribution (ERC), is the premise that each asset or asset class should have equal risk contribution to the total risk of the portfolio (Qian, 2005). Despite attracting much of research attention, besides work by Thiagarajan and Schachter (2011), the comprehensive review of existing literature on risk parity remains mostly unattended.

This review article focuses on three objectives. First it builds a firm foundation for advancing knowledge (Webster & Watson, 2002). Second, it synthesizes the existing body of domain knowledge on risk parity approach as many literature reviews agree that synthesizing the existing studies is crucial for any good literature review (Cooper, 1998 ; Fink, 2014 ; Hart, 1998). Third, it identifies research gaps in existing literature as many articles like Hart (1998) and Jennex (2015) etc. suggested that a review article should identify what needs to be done by highlighting research gaps as future research opportunities.

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Review of Historical Development Responsible for Emergence of Risk Parity Approach

(1) Early Studies : Asset allocation as part of portfolio management dates back to centuries. As per Duchin and Levy (2009), around 1500 years back, the Babylonian Talmud made recommendations related to diversification that an equal amount should be distributed among all assets which can be called equal-weight approach. The idea of applying the mean variance approach in modern finance was first used by Finetti (1940) to solve reinsurance problem as stated by Rubinstein (2006). However, more structured development started in portfolio management when Markowitz (1952) established the mean - variance optimization framework as a sound hypothesis to identify an efficient set of portfolios. It was the work of Roy (1952) which contributed significantly to theoretical development by providing mathematical logic to weight calculation (how much to hold) and optimal distribution among *n* assets (which assets to hold).

(2) Studies on Estimation Risk and Remedies in Mean Variance Framework : Though theoretically sound, the mean variance framework has found difficulty in acceptance by practitioners in the real world. High degree of estimation risk prevailing in the mean variance framework has contributed towards its unsuitability. Kalymon (1971) described estimation risk as the second component of risk which comes from lack of perfect information about the parameters of the model. Many studies like Barry (1974), Michaud (1989), Chopra and Ziemba (1993) highlighted in detail the high risk of estimation errors in mean variance framework and problems with using mean variance optimization framework for portfolio construction.

Studies such as Merton (1980) and Best and Grauer (1991) supported that estimation of returns was more prone to estimation error as compared to estimation of covariances, and sensitivity of parameters was high to the change in the asset means.

Significant amount of research literature is devoted to cure or reduce the estimation risk in mean variance framework. Different approaches like Bayesian approach (Jorion, 1985 ; Jorion, 1986; P´astor, 2000), non - Bayesian approaches (Best & Grauer, 1991; Chan, Karceski, & Lakonishok, 1999 ; Ledoit & Wolf, 2004) and other approaches like Black and Litterman (1991) and Black and Litterman (1992) models, etc. were proposed to solve estimation risk problem in the mean variance model. Despite considerable progress in the development of such alternative models, the success of such models has remained elusive in the real world. One reason for this is, many of such methods are mathematically complex, computationally demanding and generating poor empirical and out of the sample performance. The study of DeMiguel, Garlappi, and Uppal (2009) compared 14 different asset allocation methods across eight different datasets and found that none of the asset allocation model consistently outperformed equal weight strategy in terms of Sharpe ratio, certainty-equivalent returns, and portfolio turnover.

Another reason for poor acceptance of such alternative models is found as investors' inclination towards using simple allocation rules in the real world while allocating their wealth based on studies like Benartzi and Thaler (2001) and Huberman and Jiang (2006).

(3) Studies on Diversification of Portfolio in Mean Variance Framework : Especially after the 2008 crisis, modern portfolio theory (MPT) has received much criticism from industry practitioners for generating optimal portfolio, which is concentrated in few securities resulting into under diversification and improper risk control (Lee, 2011; Thiagarajan & Schachter, 2011). The question of how many securities a portfolio should have to be called diversified portfolio was first addressed by Evans and Archer (1968) by highlighting that increase in diversification, which led to decrease in portfolio risk, was due to reduction in unsystematic risk. An attempt was made by Booth and Fama (1992) to quantify the additional returns generated due to diversification. However, it is important to note that despite having so much financial literature written on portfolio diversification and risk

reduction, there remains a lack of consensus on diversification as Meucci (2009) stated, "Oddly enough, there exists no broadly accepted, unique, satisfactory methodology to precisely quantify, and manage diversification" (p.74). The quest for effective diversification and better diversification measure has led practitioners and academicians to explore approaches like risk parity approach, most diversified portfolio approach (Choueifaty & Coignard, 2008) etc., which are collectively called risk based approaches as portfolio risk reduction is their prime motive. Among these, the risk parity approach has gained more traction as it is intuitively appealing to risk diversification as the main aim of portfolio decision making (Thiagarajan & Schachter, 2011), has financial interpretation and economic intuition, and is heuristic in nature (Lee, 2011).

A vast review of financial literature as an endeavor to understand the backdrop for the emergence of risk based approaches and especially risk parity approach has confirmed two observations. First, unsuccessful adoption of various alternative methods to reduce estimation errors in mean variance framework in the real-world setting, and second, observation being non-existence of consensual and effective risk diversification concept with strong economic intuition. These two observations have mainly contributed towards the emergence of risk parity as a risk based approach, which is represented in the Figure 1 that depicts the overview of emergence of risk parity.

Figure 1. Outlining the Evolution of Risk Parity Approach
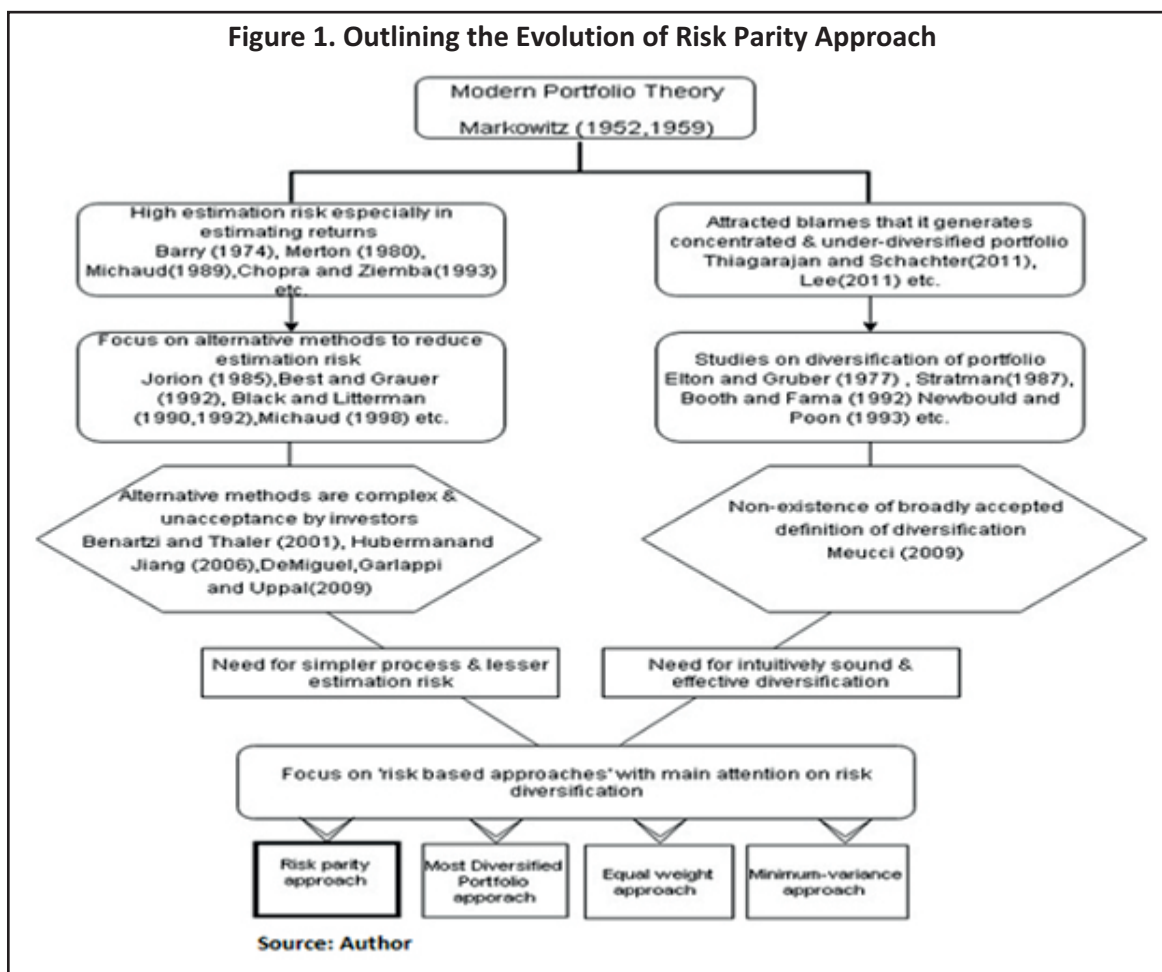
Methodology

The process of identifying papers for literature review is outlined in the Figure 2 ; 786 literatures were identified

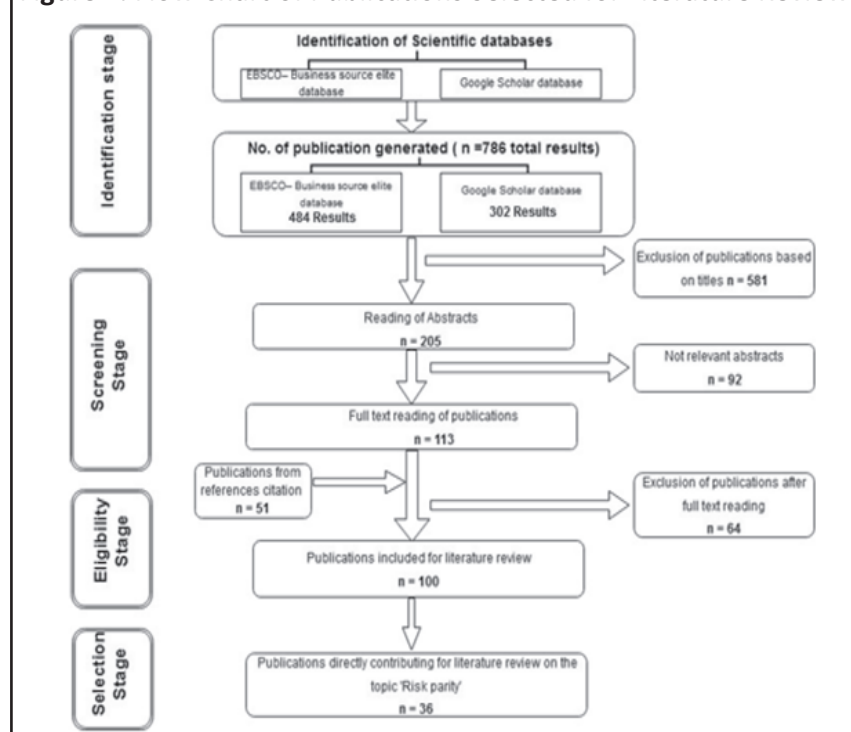**Figure 2. Flow Chart of Publications Selected for Literature Review**

Year of Publication	Number of Journal Papers and White Papers	%
2005	1	3
2006	1	3
2009	2	7
2010	1	3
2011	8	28
2012	8	28
2013	1	3
2014	1	3
2015	4	14
2016	1	3
2017	1	3

Table 1. Number of Publications Each Year

using combination keywords such as "risk parity," "portfolio management," "risk based approaches," "risk contribution," etc. through two databases namely 'EBSCO-Business Source Elite' and 'Google Scholar'. Out of 786 results, 100 publications were found relevant for literature review. Finally, 36 publications which included publication only from peer reviewed journals and white papers from practitioners were selected as directly contributing to literature review on risk parity. Out of 36 publications, 31 were published in peer reviewed journals and 5 were white papers.

Year-wise publication break up for 36 publications which directly contributed to literature review is provided in the Table 1. The observation shows that there was a high amount of research concentration (56%) in the year 2011 and 2012. In recent years, research publication on risk parity has been on the lower side.

Table 2. Journal - Wise Break up of Papers' Contribution for the Review

Sr. No.	Journal Title	Number of Papers	%
1	*The Journal of Investing*	10	28
2	*Journal of Indexes*	1	3
3	*The Journal of Portfolio Management*	8	22
4	*Financial Analyst Journal*	2	6
5	*Annals of Operations Research*	1	3
6	*The Review of Financial Studies*	1	3
7	Neuberger Berman - White Paper	2	6
8	PanAgora Asset Management - White Paper	2	6
9	*The Journal of Finance*	3	8
10	*Econometrica*	1	3
11	*Journal of Political Economy*	1	3
12	*Journal of Investment Management*	1	3
13	*Quantitative Finance*	2	6
14	Bridgewater Associates -White Paper	1	3

Table 3. Number of Papers as First Author (with Two or More Publications)

S. No.	As a First Author	Number of Papers	
		In Journals	White Papers
1	Edward Qian	2	2
2	Vineer Bhansali	3	
3	Denis Chaves	2	
4	Roger Clarke	2	

Table 4. Occurrence of Performance Measures in Papers

Performance Measure	Number of Papers (Inclusive of White Papers)	%
Sharpe Ratio	19	53
Excess Returns	11	31
Tracking Error	2	6
Information Ratio	2	6
Beta	3	8
Turnover	5	14
Standard Deviation	19	53
Maximum Drawdown	4	11
Diversification Ratio as defined by Choueifaty and Coignard (2008)	1	3
Skewness	3	8
Excess Kurtosis	3	8
Alpha	2	6
VaR	2	6
Herfindahl index	2	6
Gini coefficient	4	11

Out of 36 publications, the number of papers including white papers contributed by journals or practitioners is exhibited in the Table 2. Two journals namely, *The Journal of Investing* and *The Journal of Portfolio Management* made significant contribution (50%) to the literature on risk parity.

The Table 3 shows a list of first authors who had published two or more papers towards literature on risk parity out of 36 publications. However, it is worthy to note authors such as Thierry Roncalli, Wai Lee, etc., have also contributed towards literature on risk parity.

Performance measures are important tools to gauge the performance of a portfolio. The Table 4 lists 36 papers published on performance measures and number of papers it is used in. Apart from some of the well established measures, portfolio turnover (14%), maximum drawdown (11%), and Gini coefficient (11%) also got increasingly accepted.

Thematic Review of Literature on Risk Parity Approach

Literature review on risk parity is broadly divided into three themes namely, studies contributing towards concept building, empirical studies, and studies focused on methodology as depicted in the Figure 3.

(1) Studies Contributing Towards Concept Building : Though many studies, like Litterman (1996) ; Lee and Lam (2001) ; Clarke, de Silva, and Wander (2002), and Winkelmann (2004) focused on the idea of risk contribution

Figure 3. Flow Chart of Publications Selected for Literature Review
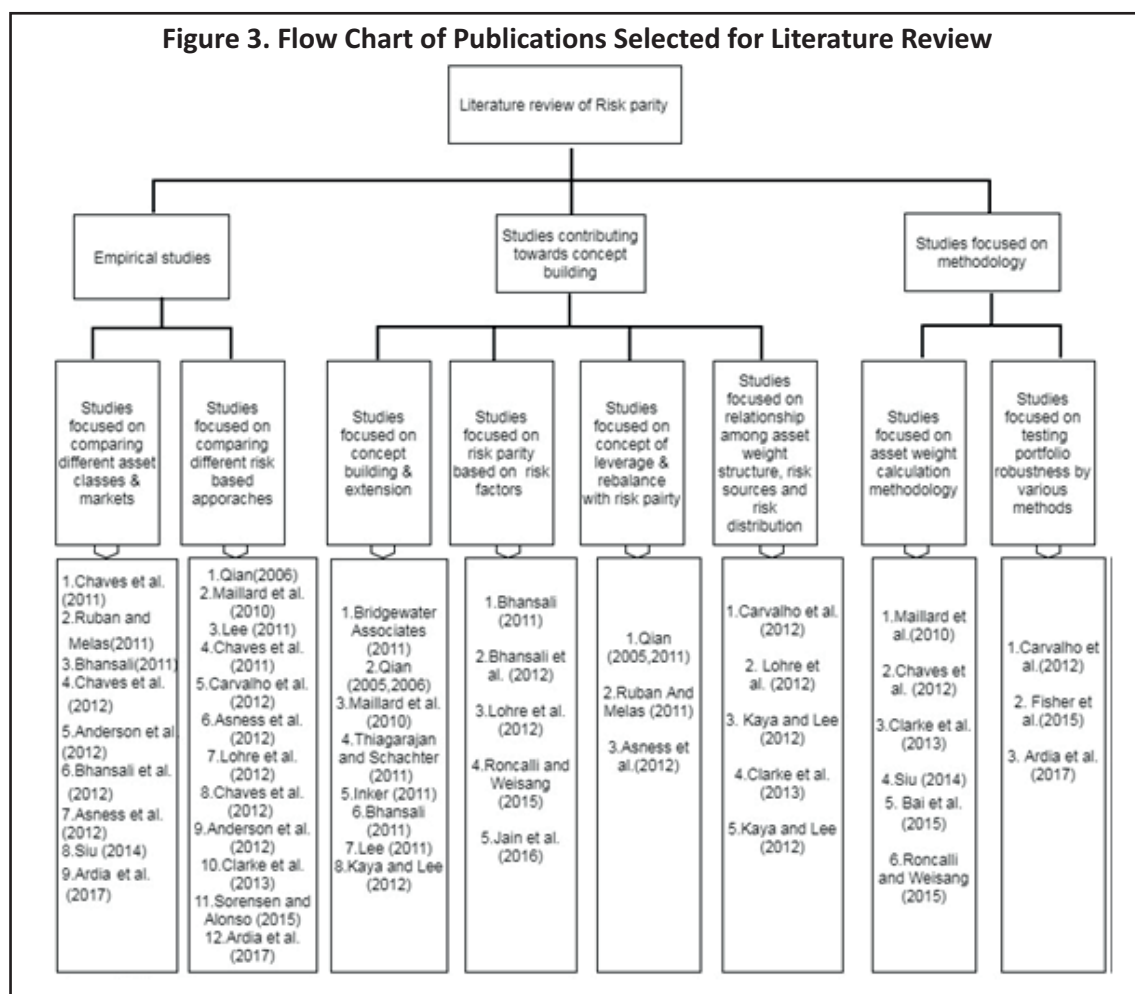
and the percentage contribution to risk in the domain of asset allocation, the concept of risk contribution has remained vague due to non-additive nature of some of the risk measures like standard deviation and value at risk (Sharpe, 2002), and the absence of clear financial interpretation. These two issues in the concept of risk contribution were addressed by Qian (2006) stating how theoretically and empirically risk contribution has strong financial interpretation. Risk parity concept was pioneered by Ray Dalio at Bridgewater Associates in 1996 (Bridgewater Associates, 2011). As stated by Roncalli (2013), the term 'risk parity' was first time coined by Qian (2005).

Qian (2005) stated that diversified 60/40 portfolio rule (60% invested in equity and 40% in bonds) is not diversified when seen in terms of risk contribution, but risk parity approach, which equally diversifies risk among all asset classes, provides superior performance in terms of Sharpe ratio, and leveraged risk parity portfolio can achieve superior performance in terms of high Sharpe ratio as well as higher returns. Qian (2009) extended the understanding by proposing risk parity based index construction as the study showed that there was a non-linear relationship between risk contribution and capital weights from the assets in the index which raised questions on efficiency of cap-weighted index. It was Maillard, Roncalli, and Teïletche (2009)'s work, which laid the theoretical framework by delineating the properties and defining the equally weighted risk contribution portfolios (ERC) which are also called risk parity portfolios. Importantly, it defines mathematically the marginal risk contribution and total risk contribution. As under the ERC approach, the marginal risk contribution of every asset or security should be the same as the marginal risk contribution of every other asset or security so that every asset's risk contribution is at par with every other asset's risk contribution to the total risk of the portfolio. These properties also identified the existing inverse relationship between the volatility of the asset and its weight in the ERC portfolio. The paper highlighted under which conditions the ERC portfolio attains to maximum Sharpe ratio (MSR) portfolio leading to the optimality of the ERC portfolio. Extension of theoretical development by raising critical questions and throwing light on unexplored dimensions is equally essential as laying the foundation for the theoretical framework. The review work of Thiagarajan and Schachter (2011) raised important questions - like for the articulation of policy portfolio, can risk parity be used for guidance and can study of risk parity as heuristic approach help in understanding human nature? ; can it help evolve a paradigm of decision making under risk by better reflecting the nature of uncertainty? The article suggested that risk parity being heuristic approach can be evaluated under conditions where the heuristic approach is optimal like comparing with outcome of models under fuzzy probabilities. One caution highlighted in the study is that levered risk parity portfolio has leverage cost and also timing risk associated with it while taking leverage.

One strong criticism the risk parity approach has received was discussed by Lee (2011), which is the lack of clearly defined objective as to what the risk parity portfolio is trying to solve. Another important question raised was how valid it is to compare the performances of risk based approaches, including risk parity portfolio based on Sharpe ratio or other risk adjusted returns since these return based measures do not enter into objective function. However, among all risk based approaches visited, Lee (2011) viewed risk contribution (risk parity) portfolio as more applicable due to providing freedom for deciding targeted risk contribution profile and its economic intuition, financial interpretation of economic loss, and heuristic nature. Kaya and Lee (2012) tried to answer the question raised by Lee (2011) by providing mathematical support for risk parity as a solution to utility maximization and existence and uniqueness of the risk parity portfolio.

Constructive criticism is very fruitful for the robust development of any concept. Inker (2011) highlighted the dangers of risk parity by stating that standard deviation as a risk measure used for determining weights and leverage is risky as it is based on one-time historical data. Inker (2011) also observed that many of the empirical studies focusing on risk parity's comparison with others tend to start around 1980 of USA markets, which have provided very much favorable performance for risk parity. As risk parity portfolios are used often with leverage and with multiple asset classes, Inker's (2011) opinion is noteworthy that in the long term, very few assets can offer reliable risk premia and leverage coupled with a standard deviation as risk measure can prove harmful.

The traditional risk parity approach works on equalizing risk across assets, while Bhansali (2011) proposed a more robust approach where risk is allocated to risk factors embedded inside assets. Extension of the risk parity concept from traditional asset based allocation to risk factor based allocation thrives on sound logic, but as Bhansali (2011) pointed out, sophisticated modeling and ability to estimate the exposures by performing stress tests is required to measure various factors' exposure in the asset. Bhansali, Davis, Rennison, Hsu, and Li (2012) extended Bhansali's (2011) work by outlining the analytical framework for constructing risk factor based risk parity wherein key risk factors were identified using principal component analysis. Lohre, Neugebauer, and Zimmer (2012) added one more dimension by identifying uncorrelated risk sources with the use of principal component analysis and then equally distributing risk to each of this uncorrelated risk source to gain maximum diversification of the portfolio. Achieving diversification through the decomposing risk of the portfolio into risk factor contributions was proposed by Roncalli and Weisang (2015) wherein the diversification problem in terms of risk factors was formulated as an optimization program. Jain, Rosenthal, and Lee (2016) explored the concept of applying risk parity on the alternative risk premia which was identified in the study based on four factors across four major asset classes.

Portfolio leveraging was used to boost the portfolio performance; also, rebalancing the portfolio was seen as having an impact on the performance of the portfolio. Qian (2005) and Qian (2011) made the argument that the unlevered risk parity portfolio has a higher Sharpe ratio, but lower total returns when compared empirically with other approaches. To remove this problem, levered risk parity portfolio was suggested, which achieved a higher Sharpe ratio as well as total returns. The question of whether from volatility reduction stand point, it is optimal to add leverage was addressed by Ruban and Melas (2011) who suggested that it depended on the correlation between asset classes if it was negatively correlated, then leverage adding can reduce portfolio volatility. However, there may exist additional liquidity risk with a leveraged portfolio. In the real world, many practitioners, either by choice or by inability, do not use leverage for enhancing portfolio performance. With such a backdrop in the world of leverage aversion, how does risk parity portfolio survive was discussed and validated by Asness, Frazzini, and Pedersen (2012) by providing theoretical justification as to how superior performance of risk parity was one more instance of leverage aversion theory under which investors are averse to leverage.

Some literature has focused on understanding the relationship between asset weight structure and sources of risk in the risk parity portfolio. The concept of understanding how many factors contribute to explaining the difference between excess returns of risk based strategies over market cap index was empirically tested by Carvalho, Lu, and Moulin (2012) resulting in identifying the five factors which were explaining the behavior. Three factors as market excess return, low beta, and small cap have shown the highest explanatory power. The relationship between weight of the asset and sources of risk, namely systematic risk and idiosyncratic risk was explored in studies like Kaya and Lee (2012), and Clarke, de Silva, and Thorley (2013). Under one factor, world risk parity outperformed known price anomalies by favoring assets having low beta, and low idiosyncratic risk was observed by Kaya and Lee (2012); whereas, Clarke et al. (2013) analyzed the weight distribution as a function of risk by observing that asset weights decreased with the presence of both systematic risk and idiosyncratic risk, where systematic risk played a dominant role.

(2) Empirical Studies on Risk Parity Approach : Mere theoretical development or extension of concept generates less creditworthiness unless it is empirically tested. The risk parity approach has received many empirical back-testing wherein comparison to different asset classes and markets is done. Chaves, Hsu, Li, and Shakernia (2011) did back test of risk parity with five other risk based strategies for nine different asset classes as a part of the portfolio for the time period of 1980 to 2010. The study found that though risk parity had a higher Sharpe ratio as compared to other approaches, consistent out performance was lacking. Importantly, this study highlighted the sensitivity of risk parity to inclusion decision for assets by comparing the performance of nine asset class portfolios with five asset class portfolios. Siu (2014) focused on equity only portfolio for nine different European

market indices. The study tested at three layers - first layer was at individual asset risk level, second layer was risk parity over a grouping of stocks as one asset class, and at third layer, risk parity was constructed based on risk factors. One observation of this study was as a portfolio got bigger, the risk-return profile tilted towards systematic risk factors and portfolio behaved like low-beta, small-cap strategy. Second observation, asset risk parity generated superior performance in terms of Sharpe ratio, tracking error, and turnover as compared to other cap-weighted indices for the 2005 to 2013 time period. Bhansali et al. (2012) showed empirically the superiority of risk-factor based risk parity portfolio over asset-based risk parity portfolio in which with principal component analysis, the study identified two dominating risk factors over nine asset classes.

Chaves, Hsu, Li, and Shakernia (2012) conducted empirical testing at three levels wherein the risk parity portfolio with 10 asset classes and risk parity portfolio with only equity asset class generated better Sharpe ratio and lower Gini coefficient (risk allocation) when compared with other four risk based approaches for the period of 1991 to 2012. The study of Ruban and Melas (2011) suggested that the volatility of leveraged risk parity portfolio was higher compared to an unleveraged portfolio without rebalancing for the period from 1976 to 2010 of the portfolio consisting of fixed income and equity for five countries. The study also showed that a high amount of leverage was needed in case when portfolio rebalancing was not applied to maintain risk parity. A study done by Asness et al. (2012) showed a higher Sharpe ratio generated by a risk parity portfolio when tested over 11 developed countries' indices. Anderson, Bianchi, and Goldberg (2012) did back testing for a long period of 1926-2010, and observed that unleveraged risk parity portfolio dominated over the period in terms of Sharpe ratio, while leveraged risk parity underperformed in terms of Sharpe ratio over a long sub-period when compared with other three strategies.

Parting away from typical back test of risk parity, Ardia, Bolliger, Boudt, and Gagnon-Fleury (2017) undertook a study to test the sensitivity of risk based approaches to estimation error in the estimated variance and covariance. This study performed a Monte Carlo study on six different datasets for a period from 2008 to 2014 leading to the conclusion that higher portfolio concentration led to increased sensitivity towards misspecification in covariance. The study found equal risk contribution and inverse-volatility weighted portfolio being more robust to misspecification in covariance. The study of Lee (2011) showed that among five risk based strategies, risk parity generated better returns to risk ratio for the portfolio consisting of 10 USA equity sectors. Carvalho et al. (2012) observed for the time period from 1997 - 2010 that equal weight, equal risk budgeting, and equal risk contribution strategies were having low turnover and tracking error against market-cap index ; wherein, equal risk contribution had tilted towards low-beta stocks.

Five risk based approaches, which were compared in the study of Lohre, Neugebauer, and Zimmer (2012) against a market index from 1989 to 2011 in the USA market showed that diversified risk parity strategy, which allocated equally to un-correlated risk sources, had best Sharpe ratio and lowest maximum drawdown. Clarke et al. (2013) showed that risk parity achieved a higher Sharpe ratio against three other risk based strategies and market index for equity only asset class where 1000 stocks were part of the portfolio from 1968 to 2012. With the aim of incorporating investment horizon of the investor as to see portfolio's resale value at some future specified date, Sorensen and Alonso (2015) tested risk parity over multiple time periods as different investment horizons. This study showed dominance of risk parity in volatility regimes and inflation regimes from 1995-2014 for all possible and overlapping time periods against S&P500 index.

Many empirical studies have shown favorable outcomes for risk parity portfolio; however, a reader should keep few caveats in mind in context of empirical studies, as stated by Chaves et al. (2011), that asset inclusion decision has an impact on the performance of risk parity and other strategies. Anderson et al. (2012) observed that even for a long time horizon, start and end dates of back test could impact the results.

(3) Studies Focused on Methodology: Being a heuristic approach, risk parity has not consensually and theoretically accepted a common methodology for asset weight calculation for optimization function. Maillard et

al. (2009) proposed an algorithm to solve non-linear optimization problem for equally weighted risk contribution portfolio (ERC). The algorithm tries to minimize the variance of risk contribution among the assets with equality constraint. Two algorithms were proposed by Chaves et al. (2012) in which one algorithm applied Newton's method to solve a system of non-linear equation as an iterative process.

Another algorithm was based on power method which provided an iterative algorithm to find an Eigen vector from the general variance - covariance matrix. Analytical solution to calculate asset weights was designed by Clarke et al. (2013) under the assumption of a single factor risk model. This study proposed analytical framework for asset weight calculation under risk parity portfolio, which established the relationship between beta of the asset, idiosyncratic risk of the asset, and the total risk of the portfolio. Modeling risk parity as an optimization constraint instead of keeping it as an objective function was proposed by Siu (2014), who claimed that by doing so, the objective function was free to be used for achieving other investment goals and helped in analyzing different applications of risk parity. Due of non-convexity nature and if positive weight constraints are not there, there can be numerous solutions to risk parity optimization. To overcome this Bai, Scheinberg, and Tutuncu (2015) identified non-convex least square model, which generated a feasible portfolio out of all possible solutions which is closest to the risk parity portfolio based on some criteria.

Minimizing the risk concentration between risk factors as a methodology to construct a risk parity portfolio in order to match some risk budgets with risk factors was proposed by Roncalli and Weisang (2015). As testing robustness of the risk parity portfolio is equally important, the study of Carvalho et al. (2012) showed that equally weighted risk contribution (ERC) portfolio is robust as it is mostly insensitive to selection of risk model, change of time period, and a change in frequency of data. Similarly, Fisher, Maymin, and Maymin (2015) showed parametric conditions under which risk parity was superior to other portfolios, including tangency portfolio as well. This study stated outperformance of risk parity under uncertainties by providing mathematical validation for it. Robustness of risk parity against the estimation errors in the variance - covariance matrix was tested by Ardia et al. (2017), who found it to be superior to other risk based approaches.

Conclusion and Future Scope of the Research

One of the primary roles of literature review is showing future research opportunities by throwing light on existing research gaps. Some research opportunities include assessing contribution of human nature and behavior under uncertainty and risk diversification towards development and acceptance of risk parity as a heuristic approach (Thiagarajan & Schachter, 2011), development of risk parity as an optimal portfolio with model of expected returns and methods for asset class evaluation for inclusion into the risk parity portfolio (Chaves et al., 2011), and designing the risk parity model with clearly defined objective. Lee (2011) conducted a comparative study of risk parity being a heuristic approach with the model providing solution under fuzzy probability (Thiagarajan & Schachter, 2011), which is waiting to be explored. Amidst a variety of methodologies for asset weight calculations proposed to aim for risk parity optimization, there remains considerable opacity and disagreement among researchers (Chaves et al., 2012) and there exists less of discussion on methods for building a risk parity portfolio (Siu, 2014). Some research light on these issues can also be very contributory to the literature.

Apart from the earlier stated research opportunities in literature, I identified future research scope based on literature review. It is observed that most of the empirical studies have focused on USA markets and other developed countries' markets. As emerging countries are becoming the cynosure for global institutional investors, application of risk parity on emerging markets can add some interesting finding in existing literature. Risk parity's application on multiple asset classes as a part of portfolio is intensely researched, but focusing on a single asset like equity only as a part of portfolio and applying risk parity at the individual security level remains less explored. As an asset manager generally oversees many different size portfolios, it would be interesting to

explore the impact of portfolio size on risk parity performance. Comparison of different asset weight calculation methodologies for risk parity portfolio can throw some light on how the methodology impacts the outcome of the risk parity portfolio resulting in a better methodology selection decision for managers.

Risk parity approach for asset allocation in a portfolio is not a panacea, but increased acceptance by practitioners and grabbing higher attention from researchers shows that risk parity is emerging as a strong contender among existing alternative risk based approaches.

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