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DEMYSTIFYING OPTIMAL WELFARE WEIGHTS CONTROVERSY FROM A SOCIAL STRATEGIST PERSPECTIVE

Rohit MALHOTRA[a]

Abstract

What are "welfare weights", here in terms of welfare economics; a welfare weight strategy can be understood as using portfolio simulation to generate mathematical optimal weights to distribute the risks of incomplete market available through restricted financial information, i.e. the use of constrained optimal weights. Author compared how ex-post optimal weights in terms of wage regression residuals matrix reduced to selective portfolio sets behave while implementing different optimization frameworks. For this, use of OLS, LAD and Quantile regression methods were used across Cement sector companies' financial data. Now, the motivation of an author is not to mere building a mathematical premise, but try to justify through supporting literature that unless a cultural transformation with subject to optimization is not respected, the phenomena will be difficult to understand. The statistical outcomes revealed that all the three methods , in terms of "post optimized percent change of weights" does not show significant difference when using impure combinations (non-normal and normal residual series portfolio) but the results strongly conceived towards LAD regression while using pure combinations (only normally distributed residual series portfolio), and hence, it is therefore, possible that a welfare strategy maintaining the thought of percent change of welfare weights can be considered as a viable tool for policy makers in future.

Keywords: OLS, LAD, Quantile regression, Risk optimization
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Author's Affiliation

[a] - Auro University, School of Management & Hospitality, rohit.malhotra@aurouniversity.edu.in

1. Introduction

"Inter-industry wage optimization is a debatable subject; "primarily because the aspect of heterogeneity associated with the economic agents with reference to rationality in allocation of resources is not merely a mechanical optimization process. Fugazza, Guidolin, & Nicodano (2010) claimed that from policy perspective this is important, since a large correlation between wage shocks in one industry in comparison to the financial shock as a whole denotes lesser protection to the workers.

Before beginning some prominent research ideas served in this direction, it is imperative to justify that why choosing Cement sector for the study, as most evidently Cement product is mostly "homogenous" and this product characteristics makes labour cost justification far easier to comprehend in terms of degree of heterogeneity, since, in terms of skill based compensation, the degree of wage differentiation/heterogeneity could be considered fairly low or negligible.

The author limited his use of internal financial information mainly because he wish to assess the idiosyncratic relationships of employee costs and other pertinent "internal business-specific" variables impacting judgement for inter-industry welfare optimality. Another reason of published data is to provide a level of common standardization across inter-industry analysis. He intended not to use macroeconomic information (certain work (Sezer, 2006) had put emphasis on regional GDP for welfare weights) putting statistical dominance and making study less worthy for as a tool for "inter-industry" business level social strategy assessment.

2. Literature review

An important work by Felkey (2004) in this direction explained the relationship between community income sharing and resource sharing attitude which creates he efficient set of wage optimization. Dubois (2014) explanation is that welfare is also sometimes misused by 'welfare agents', the author critically site that unemployment insurance and wrongly used in certain countries by the world. Gadinis (2015) explained that how to ensure some regional or industry level reforms, private independent self-sustaining enterprises can play a greater role in social welfare.

The aspect of wage optimization in the long run can also be understood with SIGE model i.e. Sticky Information general equilibrium model. The assumption of "rational expectations" is also questioned with fitting "bounded rationality" approach towards the SIGE Philips curves on real output, real prices and real wage rates respectively.

Regarding risk sharing and cooperative strategies, an interest note was provided in Schreider, Zeephongsekul, Abbasi and Fernandes (2013) justified use of shapley value pareto optimality with Cobb-Douglas equation. Here the Hopkins's river case study was explained with the benefit of cooperative strategy over the competitive one when the agents have the similar profiles.

Advocate of heterodox approaches in economics is slowly getting the recognition. Hands (2011) elaborated his understanding by writing that welfare solution can take up newer ways of reorienting and presenting the economic problems. Modern economic theories are challenged and more pluralistic contextual socially viable economic ideas are emerging. Within this context, ruling out computational abilities of modern machines is not advocated; therefore, according to Judd and van Ryzin (2010) the power of computerization can be a source to guide social economists and social scientists in aiming their resource allocation issues more timely and conveniently. Chao and Yu (1992) presented labour market equilibrium model specifying that the service costs will be lower in poor countries compare to the rich countries; the reasons are the "state of equilibrium", according to their work, the rich countries will have almost equal wages spreading across manufacturing, services and agriculture while the same is not considered in the poor countries. One of the pioneering work by Govindu and Malghan (2005) explained the exciting evidences of Gandhian economics particularly the one penned down by Kumarappa naming as "Economy of enterprise" leading to violence to "Enterprise of Gregation" as those practiced by Honey bees to support the colony. Kumarappa belief on decentralized production and local consumption reasoned around distorted view of "economic exchange", particularly in case of perishable goods where the latter is exchanged monetarily with money (imperishable good) and therefore the moral value exchange between the two parties is not possible or complete. Two most fundamental economists of current times, Tony Lawson and Mark Setterfield, placed excellent support to my motivation to continue this work. The claim of Setterfield (2015) in this paper is that heterodox economists do not discourage mathematical modeling but also at the same time do not find it 'complete' in relation to the current socio-economic problems. So, there always lies a scope in terms of innovating a possible layering of pluralist ideas with the mathematical advocacy. That is where this research paper is dedicated too. Another paper by Adigüzel and Yüksel (2010) presented the sustainable human resources and significance of wages very well. But, it missed out the motivations of policymakers in terms of use of optimization models in wage settings. The paper defined the context of sustainability in terms of preserving the future generations. Nikova, Aspridis, et al. (2014) explained how economic crisis particularly in Bulgaria helped government being able to present optimization policies to ensure employee relations can be regained.

This is an interesting note that how crisis led people unite and share risks together. In the similar paper, ceasing the sectoral wage increase was also seen as a policy prescription which also stresses on the reason why optimal wage policies must be norm even during the 'good economy' days. A pro-crisis policy where employees can be guided effectively on optimization system linking their compensation under complete transparency and openness can somehow change the ideology of the way the mathematical economic solutions can benefit the state in curbing crisis to larger extent. Coggins, Perali, et al (2000) explained in their work that how individual household's equity is more heterogeneous since their rational utility function is examined, while from social observer point of view more altruistic ideas of equitable allocations emerged in the study. Gadinis (2015) stressed on private self-independent structures for social welfare and together with Altman (2000) cultivated the idea of how economic welfare with the income redistribution appears, only when the regional economic growth of one region does not get affected by redistribution even when the material benefit of one person is exchanged with other and further that this can happen purely from moral or ethical grounds.

The philosophical side of redistribution policy is greatly emphasized by Riva, Madama, et al (2015) where the concern for redistributive public policy as a moral or philosophical subjective phenomena was explained, some support through principle of fairness as stated conferred that individual principle of self-ownership does not let people carry right to own what they produce (in terms of goods and services) for the society. It is the right of self-ownership of only their body and actions. The egalitarian welfare is a complex process unlike maximizing aggregate welfare, because unless otherwise, the altruistic side of individuals is not discussed, the equitable redistribution measure will remain a daunting task insofar a social strategic movement is concerned. Henrekson and Johansson (2010) envisaged the idea through explaining the use of formal "collective" rule based institution with informal "habits, customs, culture" institutions in defining the High Growth firms in the economy, the authors also stressed that it is mathematical simplicity which makes formal institution studies more easier to examine, however, informal institutions sometimes show more impact in shaping these High growth enterprises. The aspect of social insurance was also discussed as it improves the pace for faster structural transformation in the economy.

One of the crudest yet sensitive issues in modern economics is inclusion of spiritual or religious principles Noland (n.d.) For example expressed how intermediate institutional structures could support religious beliefs which affect economic performances at the aggregate level. Hence, the paper strongly supported Weber views on relationship between religious belief system and economic behaviour (Buechel, Hellmann, et al, 2012).

3. Methodology

The subjective understanding of this research is to ensure that a smooth equitable risk sharing phenomena can work with regard to optimal distribution of wages, but it is evident that some intrinsic method must justify this procedure, for which the author is recommending a minimum % change of welfare weights (here optimal weights of wage regression residuals) emanating out of portfolios of wage residuals structured with internal financial information. As will be understood, the employee costs will be tested in terms of OLS and LAD methods against other internal financial information factors, in terms of their “Degree of Amplification” or in other words the sharing of advantages during the process of optimization.

So the null hypothesis which emerges is stated as:

Hypothesis 1: There is a significant difference in the % change of welfare residual weights post optimization among the portfolio selected

The methodology is based on the four step process adopted under this paper:

1. Selection of explanatory variables and explained variables (Regressors and Regressand) using Correlation matrix. Here, the Employee costs ratio (industry-specific aggregate human costs) is compared with other financial ratios from income statement and balance sheets.
2. Creating the Linear Regression model, showing the comparative advantage of independent financial factors in determining the output of human capital cost. Residual correlation matrix for OLS, LAD and Quantile regression and selecting the least correlated residual combinations for portfolio risk optimization purpose (here, the portfolio risk is considered as Macro-economic factor-risk combination).
3. Portfolio risk optimization or Factor-risk optimization (as these terms are often used interchangeably in the paper) with residuals values using GRG-Nonlinear algorithm- Under this step the risk attributes (weights) are optimized with the solver optimization tool. The weights are nothing but redistribution of macroeconomic risk capital across cement stocks based on the idiosyncratic diversification opportunity lying due to individual company-specific financial inputs).
4. Testing the significant difference with the use of t-test with reference to the optimal weights derived corresponding to OLS, LAD and Quantile regression technique.

   This is done for two different sets of data and hence a separate test of hypothesis for non-normal and normal residual series, and only normally distributed residual series. Pair-wise to test was applied on the two sets of hypothesis as laid out earlier in the Hypothesis testing and Equation sections.

3.1. *Data Source*

The last 14 years' time-series data based on annual Income statement and balance sheet of six Cement companies (sample selected based on 8 cement companies in BSE 500 list in 2014, which was later reduced to 6 companies due to one sample companies failed to pass the autocorrelation test of its growth rates) was acquired from Capitaline database. Total 8 relevant ratios historical series which were considered are as follows:

1. Employee cost/Reported Net profit (herewith EC/RNP)
2. Raw Material/Reported Net profit (herewith RM/RNP)
3. Power & Fuel cost/Reported Net Profit (herewith PF/RNP)
4. Other Manufacturing expenses/Reported Net profit (herewith OME/RNP)
5. Misc. expenses/ Reported Net Profit (herewith ME/RNP)
6. Return on Investment : Reported Net Profit/Total Capital (herewith ROI)
7. Current Ratio : Total Current Assets/ Total current liabilities (herewith TC/TL)
8. Net Current Assets/ Total Shareholders fund (herewith NCA/TSF)

These ratios growth rates were also calculated so that the data can become scale invariant and the issue of Autocorrelation (if any) can be handled to an extent.

First step:

1. Selection of Explanatory variables and explained variables (Regressors and Regressand) using Correlation matrix.

Firstly, in order to check the feasibility of considering in the dependent and independent space, the ratios were put into correlation matrix. And thus, the desired ratios were put into dependent and independent categories for further tests (see Table 1 in Annex). The data was converted to a time-series format in Gretl and four important tests were conducted along with OLS parameter estimation with HAC criteria on the Growth rates: the Heteroskedasiticity test, the Normality tests, the Autocorrelation test at lag 1 and The Volatility Inflation factor test.

The analysis of study continued with stress on selection of right variables for regression equations (mainly three regression equation were studied), regression parameters with p-value, SE of regression and R squared and Adjusted R squared.

Creation of Regression equations:

$$y_{EC/RNPt} = \beta_1 + \beta_2 x_{OME/RNP} + \beta_3 x_{CR} + \beta_4 y_{NFA/TSF} + \varepsilon_t \qquad (1)$$

Further a second multivariate equation was desired, for which, the second largest regressor with Employee cost/ RNP growth rates was found to be Selling and Admn cost/ RNP growth rates at 0.9786. This exogenous variable also had weak negative correlation.

$$y_{EC/RNPt} = \beta_1 + \beta_2 x_{S\&A/RNP} + \beta_3 x_{CR} + \beta_4 y_{NFA/TSF} + \varepsilon_t \quad (2)$$

Third equation will consider multicolinearity issue which exists between S&A/RNP growth rates and OME/RNP growth rates respectively.

$$y_{EC/RNPt} = \beta_1 + \beta_2 x_{OME/RNP} + \beta_3 x_{S\&A/RNP} + \beta_4 x_{CR} + \beta_5 y_{NFA/TSF} + \varepsilon_t \quad (3)$$

2. Residual correlation matrix for OLS and LAD regressors and selecting the least correlated residual combinations for portfolio risk optimization purpose.

Concept of Breakdown points in OLS and LAD methods:

The OLS method is based on the following equation:

$$\ell_2 norm = \left\| y_{EC/RNPt} - x\hat{\beta} \right\|_2 = \sum_{i=1}^{n} \left(y_{EC/RNPt} - x\hat{\beta} \right)^2 \quad (4)$$

The least square regression estimator has the lowest breakdown point based on several trials of contamination denoted by "m" in the datasets. With least square approach, the breakdown point reaches earlier (Giloni, Simonoff, et al, 2006). The range of breakdown point is between 1/n and 0.5. There are two important computational issues with OLS; firstly since it is second-degree normalization process, and square values are used, the computed values are not correctly estimated. Secondly, the breakdown point in the OLS is coming early compare to the other robust methods.

Usefulness of LAD method:

$$\ell_1 norm = \left\| y_{EC/RNPt} - x\hat{\beta} \right\|_1 = \sum_{i=1}^{n} \left(y_{EC/RNPt} - x\hat{\beta} \right) \quad (5)$$

The breakdown point of LAD usually remains high in comparison to OLS method. Usually, LAD being more robust, the algorithm behind running contaminations "m" takes more time for LAD which makes LAD more optimal estimator of regression coefficients than OLS method.

Quantile Regression Method:

By far, both OLS and LAD methods are based on "conditional mean" distribution approach, where normality assumption is paramount, because p value demands parametrization. What if there will be skewness, and mean and median may not be equal, or what if off-median central tendency exist in the distribution data (heteroscedasticity). The present data is low frequency data, unlike stock prices, hence, eliminating Heteroscedasticity with ARCH or GARCH family models will not be fruitful, since question of "autocorrelation" does not usually a concern. To overcome this, Quantile regression provide advantage of conditional shifts in location and shape both.

In the present case, 3 quantile, equi-distant at 0.25, 0.5 and 0.75 are considered, and therefore the equation emerges as:

$$y_{EC/RNPt} = \beta_1^{(p)} + \beta_2^{(p)} x_{OME/RNP} + \beta_3^{(p)} x_{S\&A/RNP} + \beta_4^{(p)} x_{CR} + \beta_5^{(p)} y_{NFA/TSF} + \varepsilon^{(p)}{}_t$$
$$where = 0 < p < 1(population - proportion - score < quantile(p) \quad (6)$$

Further to understand conditional median and off-median combination in distribution, consider the following equation (for say a linear, three-variable model) case):

$$\varepsilon_i^{(p)} - \varepsilon_i^{(q)}{}_i = (\beta_1^{(p)} - \beta_1^{(q)}) + (\beta_2^{(p)} x_{OME/RNP} - \beta_2^{(q)} x_{OME/RNP}) + (\beta_3^{(p)} x_{S\&A/RNP} - \beta_3^{(q)} x_{S\&A/RNP}) \quad (7)$$

After ascertainment of the four important criteria's the regression parameters p values, normality test p values, heteroskedasiticity p values and autocorrelation test p values, the later job is to create the residual correlation matrix and then

3. Portfolio risk optimization with residuals values using GRG-Nonlinear algorithm

Applying portfolio standard deviation (square-root of variance) as seen below, in equation number 4.

Portfolio variance is calculated as:

$$\sigma_{xy}^2 = \sigma_x^2 w_x^2 + \sigma_y^2 w_y^2 + 2 w_x w_y COV_{xy} \quad (8)$$

Once the Portfolio variance was calculated, the weights of the portfolio were kept at 0.5, 0.5 (2 asset portfolio), but later a solver simulation was applied to check how the change in the weights minimize the portfolio risk in the given set of portfolios.

4. For test of hypothesis, a t-test using pair-wise samples will be considered; this will be used with simple assumption of normality distribution of data variables into consideration.

4. Findings and discussion

The findings were done while considering two important set of information, firstly, as per the correlation analysis conducted between eight explanatory variables along with the dependent variable, it was observed that while in OLS regression India cements was inconsistent with results confirming normality of residuals (however, all the rest three tests were found negative), this was not consistent with LAD and Quantile regression results, there, the results confirmed India cements as well as Ramco cements for non-normal residual distribution (see Table 2 in Annex).

Hence, optimal weights two strategies were adopted:

With Non-normal and normal residual portfolios (here from referred as Impure portfolios) and only Normality residual portfolios (Pure combination), and for both the strategies, the usual statistical analysis of residual correlation matrix, choosing the least correlated combinations (here we took top 5 combinations), and further, the use of GRG non-linear optimization through solver to justify the post-optimal results.

Seeing the comparison of the above results across three regression methods applied, while first combination of ACC-BIRLA % change in reduction of portfolio risk was more with OLS, the optimal weight redistribution was lesser too in case of OLS. This was not the result while applying LAD and Q-Regression (Both regression techniques resulted in identical results). For Ramco-Birla the reverse case was witnessed, OLS does not change the portfolio risk and neither the shift in optimal weights were maximized, this was however true for LAD and Q-Regression where the change was comparatively very large. For rest of three combinations, all the three regression models results were close hence no such significant descriptive change was witnessed.

Referring to more important pure combination, where only normal residual distribution were considered, in OLS, the maximum portfolio risk reduction was with ACC-Shree cement of -44.4709%, while for LAD, it was Birla-Heidlberg cement combination who maximized the change in reduction of risk with -32.4724%, for Quantile regression, the % change which was maximum was for Birla-ACC witnessed a -21.8673% reduction.

How can a social-strategist witness the outcomes?

Firstly, it is evident, that unlike non-normal and normal combination (impure combination risk reduction) the optimal welfare weights risk and redistribution moved heavily, this is not the case when we try implementing LAD and Quantile regression on such residual portfolios.

Secondly, compared to OLS results of pure combinations, it is easily witnessed, that Portfolio risk reduction automatically decreasing from maximum reduction of 44.4709% in case of OLS, to -32.4724% at LAD, and down to -21.8673% in case of Quantile regression. This measures the robustness of the regression process.

With regard to optimal weight redistribution:

While, in OLS for impure combinations, the maximum change of optimal weight redistribution was witnessed at India-ACC with 96.51%, this remained almost at the similar level for LAD and Q-Regression, as the India-ACC cement combination witnessed a change of 96.55%.

Moving to normally distributed residual portfolio results, from maximum redistribution of optimal weights is concerned, as it is easily witnessed, that OLS regression provided a change of 80.043% (ACC-Shree combination), followed by LAD for 57.10% (Heidelberg-ACC combination) and further reduced to ACC-Shree combination again at Quantile regression with 96.55%.

How does average results performed in both the Pure and impure portfolio combinations (see Table 3 In Annex): It is clearly witnessed that on an average basis, for impure combination LAD and Q-Regression benefited more in terms of portfolio risk reduction is concerned, but as far as change in weights is concerned, the OLS provided more favourable results since the % change in weight is 2.83% compared to 4.17% for both LAD and Q Regression. The last column of ratio of % change in Portfolio reduction to % change in redistribution of weights makes OLS confirming its superiority.

Coming back to pure combinations, as far as % change in portfolio risk reduction is concerned, LAD took the lead at 25.2579%, followed by Quantile regression with 14.3715% and then OLS at -12.3891%. Although, in relation to the shift in portfolio weights are concerned, LAD took significant lead since for maximum portfolio risk reduction, the % change in optimal weights was also appeared at minimum level at 5.29332%. Confirming LAD performing much ahead than the other two models.

How does this help the Social Strategist?

As per the hypothesis for impure combinations, nothing much is contrasting, for all the three pair-wise hypothesis testing conducted, the results confirmed that there is no significant difference between the percent changes in the optimal weights across the three regression models (see Table 4 and Table 5 in Annex).

But, for a social strategist, the pure combination hypothesis testing results are interesting, So for hypothesis 2a and hypothesis 2b and 2c are concerned (see step 4 in the Methodology section of this paper), at two-tailed, the results are accepting the Null but if we consider hypothesis 2b and 2c together, it is clearly confirming that there lies a significant difference between results of three regression tests. Hence, the superiority of one method over other is clearly witnessed. Once this is established, it is important that from author's claim of "minimum optimal weight change for welfare purposes" the LAD regression results are more favourable when normality of residual portfolio is considered.

5. Conclusions

The redistribution of wages at the aggregate level require social system where not only the method require to be consistent, but must be easy to interpret and remain statistically and mathematically justifiable, since, the concept of redistribution of wages or realignment of workers compensation on "equity " and "just" basis require more cultural innovation. Once the mathematical work is accepted, the policy makers must infuse some "intermediary organizations" independent of private and public enterprises, where such decisions can be clearly strategized, some community leaders, social leaders, so for that matter, religious organization (keeping secular aspect in mind and only to ensure implementation of policy) a long term strategy can be prepared. As confirmed extensively in the literature, an optimal weight strategy require mathematical soundness and humanistic sensitization both, it therefore never remain a "top down" implementation. Micro-analysis of the region, the employees and workers individual ambitions, goals, cultural orientation towards cooperative firm level adaptability is required.

6. Limitations

The major limitation of this paper are two most important assumptions of classical economics which are aggregation and homogeneity of agents, these limitations are however with respect to the statistical part of the present study. The regression model presently employed excluded the idiosyncratic shocks and any tests for structural breaks, jumps and regime shifts which could make this study more structurally sound. Use of orthogonality and path-dependent tools should be utilized for better vector relationships among variables.

With regard to data, the published financial information are sometimes misleading and biased, and financial data do not express the cultural and sociological intentions with regard to human resource choices in the organization. The aspect of low frequency data and its use in setting statistical relationship among variables can be one area of unjustified limitation. Moreover, the lack of time and access to past literature with relation to the use of optimal welfare weights, and surprisingly vividness of study empirically and theoretically posed serious limitation to the results which are currently explained in this article.

7. Implications and scope of the present research

The study clearly confirmed that quantitative models pertaining to social redistribution in terms of cash transfers require a strategy which put minimum burden to the state (both fiscally and from morality perspective), hence the minimal percent change of weights ideology as stated in this paper can generate special interest to people studying this subject.

Beside this the normality assumption of yearly ratios consider important, but breakthrough researchers in “path dependent models” using evolutionary principles are expedited in recent times in contemporary areas of say “redistribution economics” and thus huge scope exist in this area for future scholars. More generally, the policies regarding welfare should be dynamic in nature, but its impact should remain semantically permanent to the “economic agents” i.e. whether using optimality principles using traditional regression models, or some sophisticated mathematical or more heterodox mixes of political morality principles, its justification of being socially relevant in specific welfare dimension must be clearly stated to the economic agents and should remain permanent in all respect. The paper therefore relates its outcomes with the long-term social strategic outlook to the wage redistribution problem, and also stressed on more bottom-up intra and inter-industry internal/business specific orientation of the scholars towards optimal welfare weights controversy.

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Annexe

Table 1: Pre-post Residual portfolio optimization for "Impure"* combinations (top five portfolios)

(Impure means using combination of Non-normal and Normal distribution of residual series)

OLS REGRESSION						
Portfolio combinations	Pre-optimized risk	Post optimized risk	% change (risk reduction)	Pre-optimal weights	Post-optimal weights	% change
ACC v/s Birla	6.81%	5.24%	-23.07%	0.5	0.7048	40.96%
				0.5	0.2952	-40.96%
RAMCO-BIRLA	7.81%	7.32%	-6.39%	0.5	0.6213	24.26%
				0.5	0.3786	-24.26%
SHREE-INDIA	82.16%	23.49%	-71.41%	0.5	0.9258	85.72%
				0.5	0.0714	-85.72%
INDIA - ACC	84.83%	7.57%	-91.06%	0.5	0.017	-96.51%
				0.5	0.9825	96.51%
SHREE-BIRLA	13.96%	12.14%	-13.06%	0.5	0.2985	-40.28%
				0.5	0.7014	40.28%
LAD REGRESSION	Pre-optimized risk	Post optimized risk	% change (risk reduction)	Pre-optimal weights	Post-optimal weights	% change
ACC v/s Birla	7.80%	6.10%	-21.86%	0.5	0.7728	44.55%
				0.5	0.2772	-44.55%
RAMCO-BIRLA	8.00%	7.59%	(-5.0688%)	0.5	0.5995	19.91%
				0.5	0.4004	(-19.9115%)
SHREE-INDIA	90.92%	27.29%	-69.98%	0.5	0.9434	88.69%
				0.5	0.0595	-88.69%
INDIA - ACC	91.88%	7.95%	-91.34%	0.5	0.0172	-96.55%
				0.5	0.9827	96.55%
SHREE-BIRLA	13.09%	10.93%	-16.49%	0.5	0.3213	-35.75%
				0.5	0.6287	35.75%
QUANTILE REGRESSION	Pre-optimized risk	Post optimized risk	% change (risk reduction)	Pre-optimal weights	Post-optimal weights	% change
ACC v/s Birla	7.80%	6.10%	-21.86%	0.5	0.7728	44.55%
				0.5	0.2772	-44.55%
RAMCO-BIRLA	8.00%	7.59%	(-5.0688%)	0.5	0.5995	19.91%
				0.5	0.4004	(-19.9115%)
SHREE-INDIA	90.92%	27.29%	-69.98%	0.5	0.9434	88.69%
				0.5	0.0595	-88.69%
INDIA - ACC	91.88%	7.95%	-91.34%	0.5	0.0172	-96.55%
				0.5	0.9827	96.55%
SHREE-BIRLA	13.09%	10.93%	-16.49%	0.5	0.3213	-35.75%
				0.5	0.6287	35.75%

*("Impure" means using combination of Non-normal and Normal distribution of residual series)

Table 2: Pre-post Residual portfolio optimization for "Pure" combinations (top five portfolios)

OLS REGRESSION						
Portfolio combinations	Pre-optimized risk	Post optimized risk	% change (risk reduction)	Pre-optimal weights	Post-optimal weights	% change
ACC-SHREE	13.7885%	7.6560%	-44.4755%	50.0000%	90.0200%	80.0400%
				50.0000%	9.9800%	-80.0400%
ACC-HEIDELBERG	7.6420%	7.4223%	-2.8749%	50.0000%	78.3400%	56.6800%
				50.0000%	21.6600%	-56.6800%
HEIDELBERG-SHSREE	13.7486%	13.6767%	-0.5226%	50.0000%	83.3900%	66.7800%
				50.0000%	16.6100%	-66.7800%
ACC-RAMCO	7.5996%	7.4793%	-1.5830%	50.0000%	71.9200%	43.8400%
				50.0000%	28.0800%	-43.8400%
RAMCO-SHREE	12.8297%	11.2369%	-12.4149%	50.0000%	96.3000%	92.6000%
				50.0000%	3.7000%	-92.6000%
LAD REGRESSION	Pre-optimized risk	Post optimized risk	% change (risk reduction)	Pre-optimal weights	Post-optimal weights	% change
ACC-BIRLA	8.0495%	6.0978%	-24.2462%	50.0000%	77.2800%	54.5600%
				50.0000%	22.7200%	-54.5600%
BIRLA-HEIDELIBERG	16.2478%	10.9717%	-32.4727%	50.0000%	59.9500%	19.9000%
				50.0000%	40.0500%	-19.9000%
HEIDELBER-ACC	15.7196%	12.6770%	-19.3555%	50.0000%	94.3400%	88.6800%
				50.0000%	5.6600%	-88.6800%
QUANTILE REGRESSION	Pre-optimized risk	Post optimized risk	% change (risk reduction)	Pre-optimal weights	Post-optimal weights	% change
SHREE-BIRLA	16.7000%	14.4338%	-21.8600%	50.0000%	77.2800%	54.5600%
				50.0000%	22.7200%	-54.5600%
BIRLA-ACC	7.8045%	6.0978%	(-5.0688%)	50.0000%	59.9500%	19.9000%
				50.0000%	40.0500%	-19.9000%
ACC-SHREE	8.6848%	8.0180%	-69.9812%	50.0000%	94.3400%	88.6800%
				50.0000%	5.6600%	-88.6800%

("Pure" means using combination of only Normal distribution of residual series)

Table 3: A Comparative analysis of Mean performance results of three optimization/regression approaches

	IMPURE COMBINATIONS		
MODEL	Average Portfolio risk reduction	AVERAGE % CHANGE IN THE OPTIMAL WEIGHTS	RATIO OF RISK REDUCTION TO % CHANGE IN WEIGHTS (in times)
OLS	-34.1663%	-2.8301%	12.07
LAD	-40.9506%	-4.1709%	9.82
QR	-40.9506%	-4.1709%	9.82
	PURE COMBINATION		
MODEL	Average Portfolio risk reduction	AVERAGE % CHANGE IN THE OPTIMAL WEIGHTS	RATIO OF RISK REDUCTION TO % CHANGE IN WEIGHTS
OLS	-12.3891%	-67.9934%	0.18
LAD	-25.3579%	-5.2933%	4.79
QR	-14.3715%	-63.2502%	0.23

(OLS =Ordinary least square regression, LAD=Least square deviation regression, QR=Quantile regression)

Table 4: Hypothesis testing (Two tailed) between the percentage changes of residual weights post optimization across three Regression methods

Combinations	LAD	OLS	QA
ACC vls BIRLA	-0.44551	-0.40966	-0.4455
RAMCO vls BIRLA	-0.19912	-0.24265	-0.19912
SHREE v/s India	-0.88694	-0.85716	-0.88694
Indiia v/s ACC	0.965543	0.965085	0.965543
Shree v/s BIRLA	0.357475	0.402881	0.357475

t-Test: Paired Two Sample for Means

	LAD	QA
Mean	-0.04171	-0.04171
Variance	0.519038	0.519038
Observations	5	5
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	4	
t Stat	-1.09172	
P(T<=t) one-tail	0.168153	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.336306	
t Critical two-tail	2.776445	

t-Test: Paired Two Sample for Means

	LAD	OLS
Mean	-0.04171	-0.028300513
Variance	0.519038	0.512780515
Observations	5	5
Pearson Correlation	0.998751	
Hypothesized Mean Difference	0	
df	4	
t Stat	-0.82916	
P(T<=t) one-tail	0.226813	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.453626	
t Critical two-tail	2.776445	

t-Test: Paired Two Sample for Means

	OLS	QA
Mean	-0.0283	-0.041708999
Variance	0.512781	0.519037869
Observations	5	5
Pearson Correlation	0.998751	
Hypothesized Mean Difference	0	
df	4	
t Stat	0.829152	
P(T<=t) one-tail	0.226815	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.45363	
t Critical two-tail	2.776445	

Table 5: Hypothesis testing (Two tailed & One Tailed) between the percentage changes of residual weights post optimization across three Regression methods

COMBINATION	QR	COMBINATION	LAD
Shree v/s Birla	0.486459	ACC v/s BIRLA	-0.4455
BIRLA V/s ACC	0.445504	BIRLA V/s Heidelberg	0.033289
SHREE v/s ACC	0.965543	Heidelberg v/s ACC	0.571015

t-Test: Paired Two Sample for Means

	Variable 1	Variable 2
Mean	0.632502	0.052934913
Variance	0.083606	0.258615381
Observations	3	3
Pearson Correlation	0.846715	
Hypothesized Mean Difference	0	
df	2	
t Stat	3.287954	
P(T<=t) one-tail	0.040685	
t Critical one-tail	2.919986	
P(T<=t) two-tail	0.081371	
t Critical two-tail	4.302653	