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Operational and Portfolio Efficiency Analysis of Commodity Mutual Funds

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ABSTRACT

The present study explains the data envelopment analysis two stage model framework for analysing the performance of mutual funds with respect to operational and portfolio execution efficiency. This method is used to analyse the selected sample of commodity mutual funds (CMFs). At the initial level a one-input/one-output setup, whereas at the next level a multi-input/one-output option is applied. From the results it is observed that CMFs are in inefficient in both their operational and portfolio execution processes. It is observed that they are operated in a very inefficient manner. The effectiveness of portfolio execution is directly linked to the efficiency of operational administration. Hence it is much required for the selected CMFs to prioritize their operational strategies to assure their success in the industry. The study framework has the chance of improving the performance and competitive advantages of not only Commodity Mutual Funds, but also other types of funds.

Keywords: Commodity Mutual Funds, Performance, Efficiency, Data Envelopment Analysis.

This study provides a novel two-stage Data Envelopment Analysis methodology for assessing the performance of commodity mutual funds with respect to operational and portfolio execution efficiency. The approach has been implemented on selected commodity mutual funds (CMFs). The initial stage employs a one-input/one-output setup, whereas the second stage utilizes a multi-input/one-output option. The commodity mutual funds listed in India have been chosen for the analysis, and their performance over the past decade is being considered. Based on the findings, the analyzed funds exhibit inefficiency in equally their operational and portfolio execution procedures, and they seem to be operated in an even more inefficient manner. Given the correlation between operational administration efficiency and portfolio execution efficiency, it is advisable for sample funds to prioritize their operational strategies to ensure optimal industry performance. The study approach can assist in assessing the performance of not only CMFs, but also other categories of funds.

1. OVERVIEW

Over the past few years, it is observed that the amount of funds invested in precious metals mutual funds has gone up very significantly. This has caused a change in how people view precious metals, shifting their perception from being primarily physical assets to being seen as financial assets. The surge in investor interest can be attributed to the diversification advantages provided by commodity metals, along with their established status as a secure refuge during periods of financial volatility (Lucey et al., 2015). Prior studies have consistently corroborated the notion that commodity metals exhibit low or negative correlations with conventional asset classes. Nevertheless, recent studies have prompted inquiries over the degree to which commodity metals provide diversification advantages. The existing body of study on precious metals

mostly centers around two key domains. The first topic pertains to the dynamics of commodity metals. This includes research that examines the interactions between commodity metals and macroeconomic fundamentals, monetary conditions, financial market sentiment, and exchange rates elements. Furthermore, scholars have examined the influence of inflation and other variables on commodity metals. Bank asset acquisitions (Glick and Leduc2012), the volatility index of Chicago Board Options Exchange or VIX (Lipton2013), monetary crises (ztek 2017), oil prices (Tsolas, I.E. 2020), risk aversion (Qadan2019), and the S&P 500 (e.g., Tkac, P.A. (2001). The second area focuses on studying the random characteristics of valuable metals and how their volatility spreads to other markets (e.g., Moreno, D., et al., 2014). To access more up-to-date surveys, refer to the studies conducted by O'Connor et al. (2015), (Goyal, A., & Joshi, A. 2011, and Talbi et al. 2020). The study primarily examines the performance evaluation of precious metal mutual funds (PMMFs), which is one of the various types of precious metal investing, including mutual funds, exchange traded funds (ETFs), futures, and options.

Commodity mutual funds (CMFs) (Vyšniauskas, P., & Rutkauskas, A.V. 2014), resemble stock mutual funds as they provide varying degrees of investment in mining company stocks or precious metals. CMFs are perceived by investors as a cost-effective and low-risk method to gain exposure to metals including gold, silver, platinum, and palladium (Kanuri, S., McLeod, R.W., & Malhotra, D. 2016). Investors that buy PMMFs expect to achieve greater long-term returns compared to those who solely invest in stocks (Tsolas2014). Mutual funds in India are registered investment companies that pool shareholder assets to invest in securities. According to Lai, M., & Lau, S. (2010) and Auer, B.R. (2015), the total global assets invested in mutual funds in 2014 amounted to around US$31 trillion. Out of this, around US$16 trillion represented the net assets of mutual funds in India. In 2020, the Indian mutual fund business accounted for almost 50% of the global mutual fund assets, which amounted to approximately US$ 52 trillion (Szmigiera2019). Gold, silver, platinum, and palladium dominate the precious metals trading industry and represented around 9% of commodities market trading in 2008 (Batten et al.2010). The existing literature on evaluation techniques of Mutual funds includes the Capital Asset Pricing Model (CAPM) developed by William Sharpe in 1964, other methods such as parametric and non-parametric frontier estimation methods like stochastic frontier analysis (Auer, B.R. 2015) and data envelopment analysis (Droms, W.G., & Walker, D. (1994).

The present study aims to fill a need in the assessment of mutual fund schemes by utilizing data envelopment analysis, with a particular focus on the internal dynamics of the management process. The objective of the study is to enhance the traditional single black box DEA method, as suggested by Otten, R., & Bams, D. (2000) for assessing the effectiveness of mutual fund schemes. The aim is to assess a set of PMMFs using a novel model of two-stage DEA, with the intention of revealing the complexities of the commodity mutual fund management process. The proposed method of two-stage DEA differs from the two-stage DEA strategy described by Otten, R., & Bams, D. (2003). While their technique involves regressing efficiency scores derived from DEA assessment on control variables that were not initially evaluated, our model takes a different approach. The focus is on improving the comprehension of the internal mechanisms of mutual fund management through a more sophisticated and thorough evaluation procedure.

This research makes a substantial contribution to the current body of literature in multiple ways. Firstly, it offers new and original statistics on the effectiveness of managing CMFs, with a focus on both operational and portfolio execution efficiency. In addition, the study aims to tackle the transparency concerns in mutual fund management by utilizing a two-stage Data Envelopment Analysis method to assess the effectiveness of both operational and sub-processes of portfolio management. The suggested method shall increase the commodity mutual fund performance upon the existing method two stage DEA which was developed by Białkowski, J., & Otten, R. (2010). This improvement is accomplished by altering the initial phase of analysis, shifting from a configuration with several inputs and one output to a configuration with one input and one output. The proposed model developed this revision to the analytical methodology to accurately evaluate CMFs, by leveraging a pre-existing dataset in our research endeavors.

The aims of this study:

1. Estimate the appropriate number of inputs required for the sampled CMFs outputs in the two performance dimensions.
2. Determine the CMFs that have the maximum performance among the funds that were sampled.
3. Statistically examine if there is a noteworthy correlation between the DEA metrics generated in the two performance dimensions.

The following portions of the article are organized as specified here Section II offers a thorough examination of the current body of literature. In Section III, we provide the two-stage DEA model. Section IV provides a detailed description of the data used in the study, including the specific inputs and outputs chosen for the sample of Commodity Mutual Funds (CMFs). The results and examination are showcased and deliberated in Section V. The article concludes in the last section, which

also discusses the policy ramifications. Recently, there has been an increasing amount of research that uses data envelopment analysis to evaluate the effectiveness of mutual funds. These studies can be divided into two primary types. The initial category pertains to individual research that employs DEA models to scrutinize the commodity mutual fund management process, considering it as a black-box procedure with diverse inputs and outputs. The start of this line of investigation can be traced back to the study undertaken by Droms, W.G., & Walker, D. (1994). The initial diversification DEA model was introduced by Morey and Morey (1999), whereas a more recent diversification super-efficiency DEA model was proposed by Malhotra, D et al. (2018) using a directional distance-based technique. Elton, E.J. (1987) have made substantial contributions to the literature on measuring the efficiency of portfolios. Baghdadabad et al. (2013) evaluated the efficacy of mutual fund managers, followed by later investigations conducted by Matallín, J.C., & Nieto, L. (2002) and, more recently, Singh, R., & Nanda, V. (1998). To obtain the most recent evaluations of DEA, it is recommended that readers consult the scholarly publications of Luo, G.Y. (2002), Pendaraki, K., Zopounidis, C., & Doumpos, M. (2005), Pendaraki, K et al. (2005). These models include non-linear DEA models proposed by Boudreaux, D.O., Rao, S.P., Ward, D., & Ward, S.P. (2011) and the evaluation of mutual fund executives using DEA-based methodologies. The second phase of model development focuses on the introduction of the DEA two-stage series. The DEA two-stage model, in contrast to the DEA single black box model, differentiates between sub-processes and seeks to measure their efficiency (Otten, R., & Bams, D. (2000). Prominent research in this area includes studies undertaken by Batten, Jonathan A et al. (2010), Mehta, D. (2020). Sharma, R., & Pandya, N. (2013) proposed a novel modeling approach used to evaluate the effectiveness of commodity mutual funds. This approach considers both operational and portfolio factors. Expanding upon previous research, Patel, B.K., & Patel, P. (2015) improved the model by incorporating a two-stage network topology, which enables a distinct output in the initial stage for evaluating mutual funds. Sánchez-González et al. (2017) employed Data Envelopment Analysis (DEA) to investigate the operations of Spanish mutual fund companies. Their primary objective was to evaluate the effectiveness of portfolio execution and marketing strategies to obtain in-depth thoughtful of the internal workings of these funds. Kumar, R. (2016) utilized a three-stage DEA modeling approach to assess funds in a more comprehensive manner. Galagedera, Don U. A. (2018) conducted a thorough assessment of the effectiveness of superannuation funds. This evaluation employed a two-stage DEA modeling method that included two sub-processes: operational and portfolio management. Galagedera (2019) employed a two-stage DEA methodology to evaluate the social responsibility performance of mutual funds. The initial stage output was non-discretionary. Guedj, I., Li, (2011) has undertaken a study in Taiwan to assess the performance of registered mutual funds using two-stage DEA approach.

2. RESEARCH GAP

There are still several study areas that have not been adequately studied in the existing literature. Although both single-stage and two-stage DEA approaches have been used to retroactively evaluate mutual funds, there seems to be a lack of application of the two-stage DEA method in assessing the performance of Commodity Mutual Funds (CMFs). As far as the author knows, this particular methodology has not been used to evaluate CMFs. The existing study seeks to fill this void by utilizing a two-stage DEA methodology to assess the efficacy of a specific set of CMFs, with the objective of revealing the complexities of their management procedures. Furthermore, this research enhances the current body of literature by improving the initial part of the commonly used two-stage DEA modeling approach. This improvement entails changing from a setup where several inputs lead to a single output, to a setup where a single input leads to a single output. This enhances the level of methodological complexity in evaluating CMFs.

3. METHODOLOGICAL APPROACH

The next part presents a two-stage framework that is being presented. It includes a comprehensive explanation of key variables and definitions, as well as a discussion on the modeling difficulties related to data envelopment analysis. Conceptual Framework: Bazo, J.G., & Sedano (2005) define mutual fund performance capacity as the procedure of assessing the effectiveness of both operational administration and portfolio execution inside a mutual fund scheme. Performance measurements consist of metrics that assess the efficiency of operational and portfolio management, encompassing two fundamental elements of performance. We utilize the independent technique (Koronakos 2019) to assess mutual funds in our approach, seeing each stage as functioning independently. Thus, we calculate the efficiency of each stage separately. More precisely, we utilize the independent strategy to execute a two-stage framework. The result of the initial sub-stage, known as operational administration, acts as input for the second sub-stage, portfolio execution, coupled with supplementary inputs. Put simply, input management expenses are the costs linked to the original inputs utilized in level 1 to set up the fund schemes, which are represented by their net asset value (NAV). During level 2, the net asset value (NAV) obtained from level 1, along with the level of risk (measured by standard deviation) and additional portfolio

expenses (such as front load and delayed load), are considered as inputs. The output is then generated in the form of fund returns.

The selected approach represents an advancement beyond the model introduced by Premachandra et al. (2012). Unlike the approach in Premachandra et al. (2012), we refrain from incorporating both fund size and Net Asset Value (NAV) on the same side of DEA, acknowledging the correlation between these two variables. This deviation from the conventional practice is in response to the limitation identified by Pástor, Ľ., & Vorsatz, B. (2020)., who introduced a three-stage DEA modeling approach to address this specific concern raised by Premachandra et al. (2012). Moreover, our primary objective is to improve the two-stage DEA modeling suggested by Premachandra et al. (2012) by changing the initial analysis from a multi-input/one-output configuration to a more straightforward one-input or one-output configuration. This adjustment is aimed at providing a more user-friendly tool for investors and researchers, offering greater simplicity without compromising the model's analytical power.

3.1 DEA MODELING

The primary challenges in DEA modeling revolve around selecting the appropriate model to address probable degree effects and determining the model's orientation, such as input or output orientation. Regarding DEA evaluations, the mutual funds analyzed in the present paper include funds of different sizes. Therefore, among the traditional radial DEA models, the BCC model (Banker et al. 1984) is a suitable choice as it considers potential scale effects. The analysis utilizes either the input-oriented BCC model Banker et al. 1984. BCC input-oriented model is chosen for both level 1 and level 2, at this level fund DEA based efficiency values in between 0 and unity are generated. The generated values indicate how well the selected funds are performing at each level.

4. DATA ANALYSIS

Radial DEA models can be formulated as either models that minimize inputs or models that maximize outputs. Input minimization modeling aims to reduce the size of the inputs while keeping the outputs the same. Output maximizing is seeking a proportional increase in output while keeping inputs constant. The examination of input orientation is highly referenced in the relevant literature, particularly when examining mutual funds of different sizes, where the input-oriented BCC model is commonly employed. This phenomenon can be elucidated by the fact that this model exhibits translation invariance in relation to outputs, hence resolving the issue encountered in instances of negative fund returns.

The BCC input-oriented approach was selected for both stage 1 (operational administration efficiency) and stage 2 (portfolio execution efficiency). Both stages generate DEA-based efficiency scores that range from zero to unity, representing utmost efficiency. The efficiency scores indicate the performance of each fund in each level.

4.1 DATA AND IDENTIFICATION OF INPUT AND OUTPUT VARIABLES

Input and output variables of eighteen selected CMFs are considered for the purpose of the study. Factors including net asset value (NAV), standard deviations, annualized returns, and operational expense data often utilized to compute the management expense ratio, front load, and deferred load are all part of the dataset.

4.1.1 SPECIFICATION OF INPUT AND OUTPUT VARIABLE FOR DEA

The first step in using DEA is to input the operational process management expenses (such as asset management and fund administration) and the net asset value (NAV), which stands for the net worth of the fund's assets. Competition among mutual funds is centered on service quality rather than fee structure, suggesting monopolistic competition (GAO2000; Luo2002; Haslem et al.2007; Haslem2013). The fees are not the main thing that attracts investors, albeit they can vary. According to Gao and Livingston (2008), most mutual funds compete for assets by measuring their performance.

Expenses related to marketing, administration, and asset management make up the total cost components of mutual funds. The expense ratio of a fund is its total expenditures divided by its average net assets (Sekhar2017). According to Otero and Reboredo (2018), the average management fee for PMMFs did not change from 2005 to 2015. Previous research on mutual funds found that advisory fees, which make up over 65% of the total expense ratio on average, remain relatively stable across all fund sizes. Marketing fees, on the other hand, grow in proportion to the fund's size (Gao and Livingston 2008). We anticipate that by utilizing data on fund management expenses in level 1, we will be able to unlock the DEA black box and provide efficiency in two performance dimensions: operational and portfolio execution efficiency. This is because the data set used by Musto, D.K. (2011) includes the superior funds in terms of Net Asset Value.

4.1.2 INPUT AND OUTPUT VARIABLES SPECIFICATION FOR DEA

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(i) Net Asset Value (NAV), which is the result of level 1; (ii) the standard deviation of three-year gross performance, which is a risk indicator; and (iii) front load along with deferred load are the input variables utilized in level 2. The total risk of the fund is represented by its standard deviation, which is the dispersion of returns. According to Galagedera and Silvapulle (2002) and Tsolas (2014), the output of the selected funds analysed is the three-year annualized return that is thought to capture the medium-term gross results.

Both phases employ the input-oriented BCC model for efficiency estimation. The variables that were employed in the analysis are shown in with their descriptive statistics.

Descriptive Statistics				
Descriptive Statistics	**NAV Rs. Cr.**	**3y-Standard Deviation (%)**	**Expenses Ratio (%)**	**3y-Returns (%)**
Min	26.43	25.72	0.06	10.76
Max	2041.53	32.06	0.26	15.12
Mean	601.62	29.85	0.146	13.54
Median	99.54	29.71	0.155	13.89
StandardDeviation	611.52	1.49	0.06	9.05

5. RESULTS

The subsequent part shows and analyzes the outcomes of the input-oriented BCC model for both stages. Initial Stage Evaluation—Operational administration Performance of Commodity Mutual Fund

The performance metrics produced from the CMFs DEA utilizing the input-oriented BCC model are shown in the table below. The average efficiency is approximately 45%, with a median efficiency of 37%. Out of the entire sample, just four funds, which account for 22% of the total, are considered efficient. The findings suggest that there is potential to enhance the efficiency of fund operational administration performance by reducing input, specifically management expenses, by approximately 56% (calculated as 1 minus 0.44) as shown in Table 2. This finding aligns with the selected findings reported by Premachandra et al. (2012), who contend that significant reductions in expenses (management) fees, up to 66% of expenses, are necessary for inefficient funds to achieve efficiency.

The framework of the data envelopment analysis (DEA) used in this study is a two-stage series model. The efficiency metrics will be summarized by their mean (with standard deviation), median, minimum, and maximum values. Additionally, the quantity and percentage of funds that are considered efficient will be provided.

Two-Stage DEA-Based Performance	**Min**	**Max**	**Mean**	**Median**	**Standard Deviation**	**Efficient Funds Number (%)**
Operational Administration	76	100.00	45.29	36.52	19.99	4 (22)
Portfolio Execution	85.38	100.00	94.31	100.00	4.81	8 (44)

5.1 EVALUATION OF THE SECOND STAGE: COMMODITY MUTUAL FUND PORTFOLIO

Out of the eighteen-commodity fund, eight (or 44% of the overall sample) were determined to be relatively efficient according to the input-oriented BCC model. While the median efficiency is close to 100%, the mean efficiency is close to 96%. Decreases in inputs of around 4% (= 1 → 0.96) have the potential to enhance the efficiency of portfolio management. Patel, B.K., & Patel, P. (2015) argues that inefficient funds can become efficient with massive reductions in inputs (i.e., NAV, standard deviation), yet this discovery contradicts their findings. We may be missing something here because we limited our analysis to CMFs, which makes the collection of CMFs we looked at in this study more uniform.

5.2 COMPARISON OF OPERATIONAL ADMINISTRATION PERFORMANCE VERSUS PORTFOLIO EXECUTION PERFORMANCE

The results indicate a correlation between the efficiency ratings of operating and portfolio management. Both Kendall's (0.48) and Spearman's (0.63) rank correlation coefficients show statistical significance. The results indicate a correlation between the performance of fund operational administration and portfolio management.

The operational administration-portfolio execution performance matrix was created by dividing it into four quadrants using the mean value as the dividing point. The quadrants in this study are named using the same terminology as in previous DEA investigations conducted by Cumby, R.E. et al. (2020), which are stars, dogs, question marks, and sleepers. Stars can be categorized as funds that demonstrate superior levels of both operational Administration and portfolio execution. Dogs are investments that exhibit superior operational administration performance but worse portfolio execution performance. Questionable funds exhibit subpar performance in both areas of performance. Ultimately, those who are asleep tend to get superior results in terms of managing their investment portfolios, but they may struggle with effectively managing day-to-day operations.

(I) eight stars, which make up 44% of the whole sample; (II) three dogs, which represents 16% of the overall sample; (III) four question marks, accounting for 23% of the total sample; (IV) three sleepers, making up 16% of the total sample.

5.3 LEADING FUNDS IN PERFORMANCE METRICS

The top performing commodity funds with respect to performance and which can be considered as benchmark indexed commodity funds are Nippon India Gold Savings Fund, HDFC Gold Fund, SBI Gold, Kotak Gold Fund.

5.4 COMPARISON BETWEEN TWO-STAGE AND ONE-STAGE DEA STRUCTURES

An issue worth deeper examination is the utilization of a singular DEA structure to analyze a sample of CMFs. The inputs considered for the purpose of the study are management expenses incurred by the fund as percentage of net asset value, the standard deviation of three-year gross performance, and the front load plus deferred load. The result is an annualized three-year return. In this alternative framework, we omit the Net Asset Value (NAV) from the study, as suggested by Tsolas (2014). The outcomes of the individual DEA model exhibit a significant association with the performance of portfolio execution (Pearson correlation coefficient = 0.78), whereas the correlation with operational administration performance is comparatively weaker (Pearson correlation coefficient = 0.45). Based on the findings, the single DEA structure yields comparable outcomes to our suggested stage 2 portfolio execution performance model. The stage 1 operational administration performance model offers fresh insights into the ex-post evaluation of CMFs. As a result, the two-stage DEA is more effective than the single DEA structure.

5.5 SIGNIFICANCE OF THE RESEARCH

This study suggested various improvements to the assessment of mutual fund performance. The initial improvement is the creation of an advanced methodology that utilizes a two-stage DEA model to assess the efficiency of mutual funds in both the operational and portfolio execution sub-processes. The second improvement is that the present study offers fresh empirical evidence about the effectiveness of the management process of CMFs, with a specific focus on operational and portfolio execution efficiency.

5.6 MAIN FINDINGS

This study takes an initial step in calculating operational and portfolio execution efficiency scores for a sample of CMFs using DEA-based methods. We adhere to the input minimization BCC DEA model in our specification. Based on the results, the funds evaluated demonstrate inefficiency in both their operational and portfolio execution processes. Specifically, they appear to be conducted in a particularly inefficient manner. Hence, more substantial decreases in fund inputs are required for inefficient funds to achieve efficiency. Furthermore, the utilized two-stage methodology can be

regarded as a filtering procedure to select the top-performing funds in terms of both performance metrics. Based on the results, there is clear evidence that the performance of fund operational administration is linked to the performance of portfolio management. Therefore, it is imperative for sample funds to prioritize their operational procedures to guarantee their performance in the sector.

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