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Mean-variance-skewness in destination efficiency framework: The case of France

Louisa R. Andriamasy[1] and Hanitra H. Rakotondramaro[2*]

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[1] University of Evry Val d'Essonne, EvryCedex, France; email:rabaozafy.andriamasy@univ-evry.fr
[2] IAE-Antenne of Mende-University of Perpignan, Avenue du Marechal Foch, 48000 Mende, France. email: hanitra.rakotondramaro@univ-perp.fr
* Corresponding author

Abstract

Number of overnight stays is an important variable in the context of tourism destination competitiveness. Recently, researchers suggested the mean-variance approach as a tool to measure the efficiency of this variable. However, this methodology is inadequate if the variable does not follow a normal distribution or if the decision-makers do not have a quadratic utility function. Thus, higher moments, such as skewness or/and kurtosis should be taking into consideration. The paper introduces the portfolio theory with skewness as an efficiency measure of the number of international overnight stays in France from 2002 to 2012. First, we show that this variable is not normally distributed. Then, we use a non-parametric approach based on the Mean-Variance-Skewness (MVS) introduced by Briec et al. (2007) to measure the performance of four different regional origins of international tourists staying in France. Finally, we demonstrate that the decision-makers should take the high-return/ low-risk option with a high-skewness.

Keywords: shortage function, mean-variance-skewness, efficiency, DMO.

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Introduction

The tourism sector has become one of the major generators for social and economic growth in the world and one of the leading drivers of international trade. In 2003, the World Trade Organization and the World Tourism Organization announced that by considering service exports exclusively, the share of tourism exports is nearly 30 per cent. "*Competitiveness of tourist destinations is important, especially as country strives for a bigger market share*" (Gooroochun and Sugiyarto, 2005). Success in competitive markets demands achieving highest levels of performance through continuous improvement and learning (Barr et al., 1999). Efficiency is measured to analyse the competitiveness in the tourism industry (Barros, 2005). It is also important to provide a strategic decision tool to destination manager to evaluate the performance of tourism activities (Botti et al, 2009; Barros et al, 2011). Several alternative approaches have been developed in the tourism literature to measure efficiency and productivity. For example, Botti et al. (2009) used the directional distance function to evaluate the performance of 22 French regions. Botti et al. (2012) and Ratsimbanierana et al. (2013) proposed a destination efficiency measure to minimize the instability and to maximize the return of inbound overnight stays.

Then, Jang et al (2002, 2004) explained how the modern portfolio theory developed by Markowitz (1952) could be applied to tourism. This financial theory was used to find an optimal market mix and minimized the instability of inbound tourist market demand (Kennedy, 1998; Jang and Chen, 2008; Laimer and Weiss, 2009; Loi and Tou, 2013). Along this line, Botti et al (2012) and Ratsimbanierana et al (2013) used the shortage function approach in mean-variance space to measure the efficiency of overnight stays in France and Morocco. It is important to point out that working in mean-variance space assumes that at least one of the following hypothesis must be verified: (i) assets or portfolios under evaluation have normal probability distributions, (ii) or the utility functions of investor preferences are quadratic (Tobin, 1958; Hanoch and Levy, 1969; and Leland, 1999). However, many studies (Chunhachinda et al., 1997; Prakash et al., 2003) showed that the returns of assets are asymmetrically distributed. Furthermore, Pratt (1964) insisted on the fact that quadratic function is very unlikely and it implies increasing absolute risk aversion. Together with all these criticisms, other criteria might be added to the classical risk-return one. Thus, higher moments, such as skewness, are relevant for investors to make decisions in portfolio selection and cannot be neglected (Samuelson, 1970). This odd moment expresses measures of asymmetry and it can be seen as a way to decrease the extreme values on the loss side and increase them on the gains, it is known as skewness. Among the earliest studies, Joro and Na (2005) used Data-Envelopment-Analysis in Mean-Variance-Skewness (MVS) and Briec et al. (2007) introduced a shortage function to gauge portfolio performance.

The aim of this paper is to borrow the portfolio theory with higher moments to measure the efficiency of French destination among overnight stays. It proposes a nonparametric efficiency measurement approach for a destination using production frontiers methods and directional distances. Number of overnight stays are analysed as if they were an asset or a fund, then we can hypothesize that tourist destination performance can be evaluated through the measurement of how to minimize the instability of overnight stays and maximize their growth and skewness simultaneously. It also helps destination managers in their allocation of more resources to make sure growth and stability, though the presence of non-normality such as low-cost transport price, tourism seasonality or exceptional events (terrorism, natural disasters, international sports events). For example, climate change is slowly taken into account by destination managers in the tourism sector (e.g. tourism organisations, investors, insurance companies). They must adapt their decision-making in order to minimize associated risks and create new opportunities.

The remainder of the paper is organized as follows: First, we begin with a brief description of the research methodology. Then, we present an empirical illustration. Finally, we conclude with a discussion of the research and its implications and limitations.

Theoretical frameworks

We use a non-parametric tool with shortage function developed by Briec et al (2007) to evaluate the performance of its continent. In other words, this shortage function leads to find a specific region and compares it with the efficient surface in MVS space to see how close the actual portfolios have been to optimal solutions. We first detail the use MVS approach in the general context of tourism demand analysis and then focus on the application of MVS to overnight stays. Then, we use the shortage function to determine the efficient surface of the four continents considered. This function looks for possible simultaneous expansion of return (the growth of overnight stays), reduction of risk (fluctuation) and improvement of skewness in the direction of a vector *g*.

Tourism portfolio and Efficient Frontier: Definitions

Developing some basic definition, we consider that the *n* number of overnight stays by region can be understood as comparable to *n* assets or funds in finance. Let denote $I_{i,t}$ the number of overnight stays for a specific region *i* at each time period *t*, the returns or the rate of growth is for all $t > t_0$, $R_{i,t} = \frac{I_{i,t} - I_{i,t-1}}{I_{i,t-1}}$. These overnight stays are characterized by:

- an expected return $E[R_i]$ for $i \in \{1, \dots, n\}$,
- a covariance matrix $\Omega_{i,j} = Cov\left[R_i, R_J\right]$ for $i, j \in \{1, \dots, n\}$
- and a co-skewness matrix $\mathrm{CSK}_{i,j,k} = E\left[(R_i - E[R_i])\left(R_j - E\left[R_j\right]\right)(R_k - E[R_k])\right]$ for $i, j, k \in \{1, \dots, n\}$.

Assume that France is a portfolio composed by a proportion of $x = (x_1, \dots, x_n)$ each of these *n* overnight stays $\left(\sum_{i=1,..,n} x_i = 1\right)$. We imposed the condition that $x_i \geq 0$, the proportion of overnight stays must be higher than zero. To measure the degree of efficiency of a portfolio, it is necessary to isolate a certain subset of the representation set. The set of admissible portfolios can be written as follows:

$$\Im = \left\{ x \in \mathbb{R}^n;\ \sum_{i=1,\dots,n} x_i = 1\,, x \geq 0 \right\} \qquad (1)$$

It is assumed throughout the paper that $\Im \neq \emptyset$. The return of portfolio x_i s given by $R(x) = \sum_{i=1,\dots,n} x_i R_i$ and its expected return can be calculated as follows:

$$E[R(x)] = \mu(x) = \sum_{i=1,\dots,n} x_i\, E[R_i] = x'M \qquad (2)$$

In tourism area, all sources of variation with knowable probabilities that may influence tourism flows and income tourist destination constitutes risk factors. These can be measured by variance:

$$Var[R(x)] = E\left[\left(R(x) - \mu(x)\right)^2\right] = \sum_{i,j=1,\dots,n} x_i x_j\ Cov\left[R_i, R_j\right] \;= x'\Omega x \qquad (3)$$

Assume that we have two regions A and B with same return and same variance (Figure 1), A is characterized by more likely, but small losses and less extreme gains. This pattern is reversed in B. This difference is important. When we talk about risk, we really mean '*bad surprises*'. The bad surprises in A, although they are likely, are small. The bad surprises in B are more likely to be extreme. The asymmetry of a distribution is called skewness. Cubing the deviations from the expected value

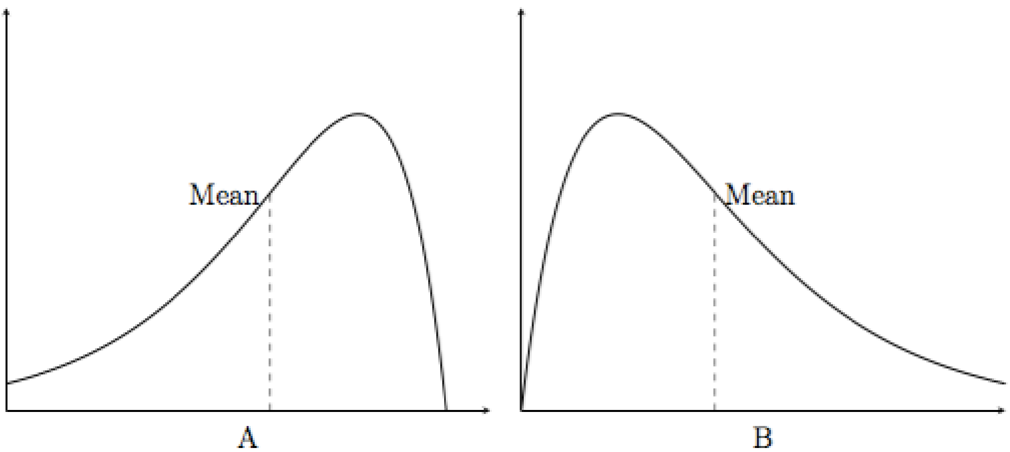

Figure 1.*Skewness between A and B*

preserves their signs, which allows us to distinguish good from bad surprises. Because this procedure gives greater weight to larger deviations, it causes the long tail of the distribution to dominate the measure of skewness. Therefore, the skewness of the distribution will be positive for a right-skewed distribution like A and negative for left-skewed distribution like B.

The skewness can be calculated by:

$$Sk[R(x)] = E\left[\left(R(x) - \mu(x)\right)^3\right] = \quad (4)$$

$$= \sum_{i,j=1,\dots,n} x_i x_j x_k \, E\left[(R_i - \right. \quad (5)$$

$$\left. -E[R_i])\left(R_j - E\left[R_j\right]\right)(R_k - E[R_k])\right] =$$

$$= x' \wedge (x \otimes x) \quad (6)$$

Following Briec et al. (2007), the Mean-Variance-Skewness (MVS) representation of the set of portfolios is defined like:

$$\aleph = \{(Sk[R(x)], Var[R(x)], E[R(x)]);\ x \in \Im\} \quad (7)$$

It represents for a given portfolio *x*, its skewness, variance and expected return. The above set can be extended by defining a MVS disposal representation set through:

$$\mathfrak{D}\mathfrak{N} = \aleph + \mathbb{R}_+ \times (-\mathbb{R}_+) \times \mathbb{R}_+$$

$$= \left\{ \begin{matrix} (S, V, E) \in \mathbb{R}^3;\ \exists x \in \Im, (S, -V, E) \leq \\ \leq (Sk[R(x)], -Var[R(x)], E[R(x)]) \end{matrix} \right\} \quad (8)$$

Because of the non-convexity of the subset $\aleph$ (see for instance Luenberger, 1998), the addition of the cone is necessary for the definition of a sort of “*free disposal hull*” of the MVS representation of feasible portfolios.

Because of the non-convexity of the subset$\aleph$ (see for instance Luenberger, 1998), the addition of the cone is necessary for the definition of a sort of “*free disposal hull*” of the MVS representation of feasible portfolios.

To measure portfolio efficiency, it is necessary to define a subset of this representation set known as the efficient frontier:

Definition 1.1 *In the MVS space, the weakly efficient frontier is defined as:*

$$\partial^M(\Im) = \{(S, V, E);\ (-S', V', -E') < (-S, V, -E) \Rightarrow (S, V, E) \notin \mathfrak{D}\mathfrak{N}\}$$

From the above definition the weakly efficient frontier is the set of all the MVS points that are not strictly dominated in the three dimensional space. The above definition allows defining the set of weakly efficient portfolios.

Definition 1.2 *The set of weakly efficient portfolios is defined, in the simplex, as:*

$$\Theta^M(\Im) = \{\, x \in \Im;\ \Phi(x) \in \partial^M(\Im)\}$$

The next section introduces the shortage function (Luenberger, 1995) as a performance indicator for the MVS portfolio optimization problem.

Shortage Function and the Frontier of Efficient Portfolios

We use the shortage function a generalization of the distance function, which measures the distance separating one point and efficient frontier. This concept was introduced by Luenberger (1992, 1995) and has been used in several sectors; Briec et al (2004, 2007) suggested an application in the financial sector, as did Peypoch and Solonandrasana (2006, 2008), Peypoch (2007) and Goncalves (2013) in the tourism industry. According to Briec and Kerstens (2007), we can use the shortage function in the setting of Mean-Variance-Skewness to gauge efficiency of a specific portfolio.

Definition 2.1 *Let* $g = (g_s, g_V, g_E) \in \mathbb{R}_+ \times (-\mathbb{R}_+) \times \mathbb{R}_+$.*The function* $S_g\colon \Im \to \mathbb{R}_+$ *defined as:*

$$S_g(x) = sup\{\delta; (E[R(x)] + \delta g_E, Var[R(x)] + \delta g_V, Sk[R(x)] + \delta g_S)\} \in \mathfrak{D}\mathfrak{N}$$

is the shortage function for portfolio x in the direction of vector g.

The pertinence of this shortage function as a portfolio management efficiency indicator stems from its elementary properties. Since these properties can be immediately transposed from the MV into the MVS space.

If $S_g(x) = 0$, the portfolio of origins *x* is an efficient point and there is no improvement. Otherwise, there is an inefficient point and the shortage function is assumed as an indicator of performance. The shortage function projects some points of the set on the efficient frontier and measures the shortcut in the direction of g, which looks simultaneously for improvements in variance reduction and mean and skewness expansion. By maximising δ, one can attempt to augment its return and skewness and reduce its risk in the direction of vector g. If δ=0, then the evaluated portfolio is efficient and part of the boundary. Otherwise, there exists a combination of other portfolios that yields a higher return and skewness and a lower risk and the evaluated portfolio is situated below the boundary, thus inefficient.

Empirical illustrations

In the context of helping destination managers in France, MVS theory using shortage function appears as a well suited tool to explain the international tourism flows.

Data description

The considered sample is the international overnight stays in France from 2002 to 2012. We segment the international tourists by four regions: Africa, America, Asia and the Pacific and Europe. All data used in the paper are obtained from INSEE (National Institute of Statistics and Economic Studies). Table 1 gives an overview of the numbers of overnight stays by region of origin in 2011 and 2012, their respective shares and the growth between these years.

Europe has traditionally been the most important tourist source for France. It represented 90% of market share in 2012. Furthermore, the number of overnight stays dropped to 177 721 966. This drop is explained by the negative annual growth rate of 1% during 2011-2012. Asia and America are the second largest tourist source region. Each continent account for nearly 5% of total overnight stays in France. Asian and American overnight stays have raised around 10% between 2011 and 2012. As given in Table 1,

Table 1. *Overnight stays in France by region of origin in 2011-2012*

Region of origins	Series	Overnight Stays ('000)		Share (%)		Change
		2011	*2012*	*2011*	*2012*	2011/2012(%)
Africa	AFR	1 125	1 261	0.6	0.6	12
America	AM	9 554	10 437	4.8	5.3	9
Asia and the Pacific	AS	8 149	8 986	4.1	4.5	10
Europe	EU	179 539	177 722	90.5	89.6	-1

Table 2. *Descriptive statistics for the number of international overnight stays from 2002 to 2012*

Region of origins	Mean ('000)	Standard Deviation ('000)	Skewness
Africa	7 096	957	0.85
America	1 006	124	0.94
Asia and the Pacific	8 940	805	0.69
Europe	176 073	3 717	0.61

Table 3. *Descriptive statistics of the rate of growth for overnight stays from 2002 to 2012*

Region of origins	Mean	Standard deviation	Skewness	Kurtosis	Jarque-Berra
Africa	0.037	0.059	0.410	2.127	0.764
America	0.033	0.079	-0.721	1.876	0.534
Asia and the Pacific	0.052	0.080	-0.342	1.543	0.615
Europe	-0.016	0.053	-1.417	4.494	0.145

there has been an increasing trend in overnight stays from Africa, accounting for an annual growth rate of 12%.

Testing for normality of overnight stay

In Tables 2-3 we present the descriptive statistics for regional tourists overnight stays in levels and in rate of growth from 2002 to 2012. Many statistical tests have been proposed to find out whether a sample is drawn from a normal distribution or not. Here we discuss the Jarque-Bera test (1981) that is based on the classical measures of skewness and kurtosis. Skewness is a measure of asymmetry around its mean and is zero for normal distribution. The kurtosis, which measures the peakedness or flatness of series, should be close to 3. If the test results support the non-normality of return distributions and the evidence also supports the skewed returns, these four regions will be analysed in mean-variance-skewness space. As a first step, it is required to test whether overnight stays for international tourist follow a normal distribution or not (Table 3). If the test results support the non-normality of return distributions and the evidence also supports the skewed returns, these four continents will be analysed in mean-variance-skewness space.

Table 3 provides a necessary variety for exposition purposes. For example, Europe has the lowest return, standard deviation and skewness, Asia and the Pacific has the highest return and standard deviation and Africa have the highest scans. One of these regions (Africa) has positively skewed in the period of 2002 to 2012. On the one hand, Asia and the Pacific show a mean of rate return overnight stays around 5.2%, and its standard deviation is also the largest. It shows the most serious instability over the period. Its situation is confirmed by the negative skewness. On the other hand, the mean of European overnight stays in France were -1.6%, but its variability is the lowest, meaning that Europe is the least volatile markets and the French market depends on its neighbouring countries.

We can also find that the value of skewness is not zero for anyone of the four regions, which implies that skewness should not neglect in measuring the performance. Furthermore, the Jarque-Bera test leads to reject the null hypothesis; it means that overnight stays for international tourist in France are not normally distributed. Hence, higher moments, one of which is skewness, must be taken into account to find the efficient frontier and the efficiency of each continent.

Continent Performance

Results

We focus on the rate of return to build the efficient frontier for Europe, Asia and the Pacific, America and Africa. The distance between the asset and its projection serves as an efficiency measure. More precisely, the distance determines if the inefficiency of the region can be explained either by growth, fluctuation or skewness. The shortage function defined earlier can be used to improve this inefficiency.

As shown in Table 4, the δ of Europe and Asia and the Pacific equal zero, then these regions are efficient and are part of the boundary. They only guarantee weak efficiency, because they do not exclude projections on vertical or horizontal sections of the non-convex frontier allowing the additional improvements. Africa and America are inefficient; improvements can be found 0.00091 in the Africa region and 0.00237 in the America.

The MV performance is not the same as the MVS one. In fact, countries inefficient in MV framework can be efficient in MVS. Instead of

Table 4. *Overnight stays performance by region of origin*

Region of origins	Performance in MVS	Ranking	Performance in MV	Ranking
Europe	0	1	0.751	4
Asia and the Pacific	0	1	0.748	1
America	0.00091	3	0.750	2
Africa	0.00237	4	0.750	2

its market share (89.6% in 2012), Europe is inefficient in MV. With considering the skewness, Europe becomes efficient and is part of the efficient surface.

Explanations

For the case of Africa, we find that the initially observed mean return of Africa is 0.037, its risk 0.059, and its skewness 0.410026. To be more specific, with skewness around 41%, the average of the growth rate of Africa from 2001 to 2012 is around 4%; the stability is about 6%. The African region is considered as inefficient. The shortage function indicates that the average growth rate should be around 26% instead of 4% and the stability should be reduced by 3%.

Considering the context of Europe, results indicate that Europe is an efficient region even if its average growth rate is around -1%. Its level of stability is nearly the same as Africa's, around 4%. The efficiency of Europe can be considered as weakly; it can be improved. The average growth rate can be increased by 12% and the stability can be reduced by 2.7%.

Conclusions

The main contribution of this paper is methodological. Starting from a sample of observed overnight stays in France with unknown probability distribution efficiency status, we find that there is non-normality in overnight stays. This property can be explained by the use of shortage function leads to project a region for which improvements can be found, in terms of increasing growth and skewness and decreasing instability. Thus, the French tourism authority can use this tool to improve its tourism strategy. By increasing the growth and the skewness of overnight stays and reducing its instability simultaneously, European and Asian regions remain efficient. Although, the market share of overnight stays in Africa is around 0.64% in 2012, the policy makers must promote its destination in this region. This potential market with overnight stays growth can be increased by 26%. We also find that inefficient mean-variance regions, such as Europe or Asia, may be optimal in mean-variance-skewness content.

We can identify some limitations of this study:

- ✓ By using historical data, the model remains prospective.
- ✓ The dual interpretations for the preference of policy makers are not taken into consideration.

However, exploiting this duality allows differentiating portfolio efficiency, allocative efficiency and a convexity efficiency part. For future research, some productivity indicator, like Luenberger productivity, can be used to gauge the performance of the destination over time. This approach might be used on other destinations.

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