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Fund of Funds Fixed Income

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Fund of Funds
Fixed Income

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Abstract

The purpose of this paper is to develop a sound analytical foundation for a new product, Fund of Funds Fixed Income, for Handelsbanken Capital Asset Management, Fixed income department. The product has been limited to debt instruments encompassing funds in the Emerging Markets and High Yield sector of the global market as well as Handelsbankens own debt instruments. The selection of external funds has been limited to five suppliers, JP Morgan, Merill Lynch, Standish Mellon, Pimco and UBS. The selection and weighting of funds will be done with basis in portfolio optimisation theory. This, combined with Style Analysis of the individual funds to determine the investment style, will form the basis for the investors' choice of funds and the comopsition of the final product. Historical data covering the period 1997-2007 will be used as basis for the analysis. The period from 2007-01-01 and forward will be excluded from the optimisation analysis and reserved for back testing the results.

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1. INTRODUCTION

Historically speaking the Emerging Market Debt and High Yield sector of the global fixed income market have yielded impressive returns. Successful investments in these market segments require specialist knowledge and long experience, a competence both difficult and expensive to acquire. By selecting funds from suitable suppliers and combining them it is possible to create a product that covers the desired market segments for a much lower cost. It may also be of interest to include funds from the fixed income segment in order to lower the total risk. The desired result is a fund of funds with the stable characteristics of fixed income funds combined with the higher yield of funds from the Emerging Market Debt and High Yield sector of the global fixed income market.

One of the issues will be selecting the appropriate funds to include in the analysis. As there are numerous funds within the target sectors I have chosen to limit the suppliers to the five investment houses, JP Morgan, Merrill Lynch, Standish Mellon, Pimco and UBS. This will cut down on the magnitude of the selection problem but still leave a sufficiently large selection of funds to form a suitable basis for the analysis.

Classical optimisation theory seems to be a promising method for achieving an optimal allocation between the different funds. This approach is normally hampered by the problem of generating accurate estimates of the expected returns for the individual assets. As the assets analysed are funds already comprised of a number of assets themselves, and thus far more stable than an individual asset, this ought not to be an issue. Furthermore, the fixed income sector is less volatile than the equity sector further reducing the potential problem.

The information available from the suppliers is often in limited supply. An external investor is entirely dependent on what the supplier chooses to reveal. A suitable method for solving the problem of limited information is to use return based Style Analysis to get an inclination to the investment style of the potential funds.

Both the selected methods only require historical data on net asset value, NAV, for the funds included as well as indices as basis for the style analysis. This information is reasonably easy to obtain.

It is also important to keep in mind that the resulting product will be a multi currency dependent product. Funds included are denominated in three different currencies, the Swedish Krona, the US Dollar and the Euro. This means that on top of the normal volatility in a given fund, one must also take under consideration the added risk from fluctuation in exchange rates. Most likely the fund will have to be hedged against foreign currencies in order to handle the added risk. The concrete construction of a suitable hedge is beyond the scope of this paper, I will however illustrate the effects of not considering the fluctuations in exchange rates.

1.1. Purpose

The main purpose of this paper is to develop a method for creating fund of funds products as well as a sound analytical basis for such products. This is done on behalf of the Fixed Income department of Handelsbanken Sweden Capital Asset Management.

A specific product, Fund of Funds Fixed Income, which is currently under development, will serve as a concrete application of the method. The purpose of the finished product is to complement their current selection of funds to cover the Emerging Markets Debt and High Yield asset classes.

The main problems to be addressed in this paper are:

1. Which are the possible optimal allocations between funds?
2. How do we secure a reliable and independent source of information regarding the funds that is necessary as a complement to the optimisation analysis?

1.2 Limits

This study will be limited to examining funds within the fixed income class covering High Yield and Emerging Markets Debt assets as well as Handelsbankens own fixed income funds. Further limitation will be imposed as only funds from five houses; JP Morgan, Merrill Lynch, Standish Mellon, Pimco and UBS, are eligible for inclusion in the product.

The historical data will cover a time period of up to ten years, 1997-2006 with 2007 reserved for back testing. Funds with a history of less than 2 years will be excluded from the optimisation analysis due to lack of data and the high risk of receiving skewed results. Those funds will however be included in the Style Analysis where such short-term data is not necessarily an issue.

Due to the time constraint necessarily imposed on this project the analysis of the impact of a multi currency product will be limited to a brief analysis of the potential problem and a recommendation towards a potential solution.

1.3 Potential problems

There are two central problems that I expect to arise that will be covered in greater detail in this paper. First, generating accurate estimates of expected return from historical data for the optimisation analysis is often problematic which merits a closer look. Second, regarding the Style Analysis, the central source of problems is that the time series used as basis for the multiple regression analysis are commonly plagued with autocorrelation. Another issue, which will be briefly illustrated but not specifically solved, is that of the added risk entailed in a multi currency fund of funds product.

1.4 Method

The selection and allocation of funds will be handled mainly with the help of classical portfolio optimisation theory complemented with the additional information garnered by applying return based Style Analysis on the funds. The combined results from these analyses will determine the answer to the third problem.

All data handling as well as the necessary calculations will be performed using a program written in Matlab. A slightly modified multiple linear regression analysis will be used to handle the Style Analysis. All regressions will be performed using E-Views, dedicated software for multiple linear regression analysis supplied by Handelsbanken. This will be complemented with a continuous portfolio evaluation tool in Excel that will also be used for back testing the results from the optimisation analysis.

2. THE EFFICIENT FRONTIER

One of the main problems to be addressed in this paper is how to construct an optimally weighted product. Which funds should be included and in what proportions?

The efficient frontier is a rather elegant and simple concept. It is essentially an optimisation problem with the purpose of minimising the total variance of a portfolio for a desired portfolio return. This enables us to solve the above stated issue at least with regard to total risk exposure. In order to create the efficient frontier all information needed is basically two measurements, the covariance matrix and the estimated return for all funds involved. Both of these can be estimated with the help of historical data of daily net asset value, NAV. There are however a few minor problems that need to be addressed in order to do so.

A simple and intuitive method of calculating the expected return is using the historical data to calculate the historical drift and volatility on a yearly basis for the individual funds and then use the drift and volatility to estimate the expected return. The volatility can usually be estimated with a high degree of accuracy, the reliability of the estimated return is however dependant of the volatility. Thus, if the volatility is too large it will, simply put, render the estimation of expected return useless. However, considering the asset classes involved combined with the fact that I am analysing funds rather than separate papers this ought not to be a problem.

An issue with using this straight approach is that a general upward or downward shift in the volatility or return of some funds may have occurred; most often both if any systematic change has occurred. If this has occurred there is a risk of systematically misestimating the expected return and volatility due to that the standard method put equal weight on all observations. A possible solution to this is to use a weighted model putting less weight on results further back in time and successively more weight on more recent data. This enables us to retain the information contained in data further back without allowing it to skew the final estimate. This seems like a reasonable approach, as the most recent data ought to contain the most accurate information available.

The chosen model has the benefits of retaining an easily grasped intuition and should yield an internally consistent set of estimates. This analysis can later be augmented with a separate market segment analysis and the corresponding estimates suitably revised. Such an analysis is unfortunately beyond the scope of this paper but it will be a part of the next step of developing this product.

2.1. Theory

As stated above the problem mathematically speaking is to simply minimise $\sigma^2(r)$ under the constraints:

$\mathbf{1} \cdot v = 1$ and $r_v \cdot v = r_p$

Where v is a *nx1* vector denoting the weights of the individual assets, r_v an *1xn* vector containing the estimated return of the assets and r_p the target portfolio return. The optimisation problem is easily solved using LaGrange's multiplicative method resulting in a parable described by:

$$\sigma^2(r_p) = \sigma_*^2\left(1 + \frac{(r_p - r_*)^2}{\tau^2}\right)$$ With the added constraint: $r_p > r_*$

Where σ^2 is the variance of the portfolio, r_* and σ_*^2 the return and variance of the minimum variance portfolio and τ^2 is a measure of the spread of r. In order to calculate the return and variance of the minimum variance portfolio the covariance matrix and expected returns are needed.

2.2. Assumptions

The validity of all assumptions made in this paper are amply covered in the basic course literature. I will therefore simply state the necessary basic assumption without proof.

A central and necessary assumption made in the analysis is that the growth in an interval of length T is approximately normally distributed given that T is sufficiently large. Studies indicate that a length over one month is sufficient for this to be valid.

The following assumptions will be necessary for the analysis:

1. The expected value and variance of $G(0,t)$, denoting the growth in the interval *0* to *t*, exists and are continuous functions of *t*.
2. For each pair $t_1 < t_2$ the expected value and variance of $G(t_1 + s, t_2 + s)$ is the same for all values of *s*.
3. The growths $G(t_1, t_2)$ and $G(t_2, t_3)$ are uncorrelated for all values of t.
4. $G(0,t)$ is normally distributed.

2.2. Key concepts

Given the assumptions stated I will now define a number of the central concepts:0

1. $v_i(t) = E[G_i(0,t)]$ The drift term of fund *i* in the interval *0* to *t*
2. $\sigma_i^2(t) = Var[G_i(0,t)]$ Variance of fund *i* in the interval *0* to *t*
3. $\mu_i(t) = E[R_i(0,t)]$ The expected return of fund *i* in the interval *0* to *t*

As mentioned before I intend to estimate both the drift term and the volatility using standard techniques. The estimations will be calculated for ten separate periods split on a yearly basis between 1997 and 2006. The historical data will then be weighted using a factor of 1/Y, where Y ranges from 1 to 10 depending on how far back in time the data lies.

Given that the estimate of the drift term and the volatility is reasonably accurate, I will then be able to use them in order to calculate the expected return of the funds. This follows from the relationship between return and growth, and in extension the return of a fund and its drift. The drift term is a central concept in portfolio theory and it is a key factor in determining the long-term development of an asset. Even though the drift term is negative the expected return can be positive due to a high volatility thus giving a misleading impression.

A direct result from the assumption that the growth in an interval of sufficient length is normally distributed is that it is possible to calculate a confidence interval for both the drift term and the variance. The size of the interval for the drift term will be the key factor in deciding whether or not the estimated returns are within reason or not.

The next central concept to be examined in greater detail is the covariance matrix, a fundamental cornerstone of the efficient frontier. Assumption number four states that an asset is uncorrelated with itself over disjoint intervals, there is no reason to assume that this is not also true for the relationship between two different assets. This leads to the following formula for estimating the covariances:

$$\hat{\sigma}_{i,j} = \frac{1}{n \cdot \Delta t} \sum_{k=1}^{n} \left(g_{i,k} - \overline{g}_i \right)\left(g_{j,k} - \overline{g}_j \right)$$

The covariance matrix takes into account not only the variance of the individual funds, but also the covariance in-between them. This resulting in an opportunity to generate a product with a total variance that is lower than the weighted total of the individual funds but still reaping the full benefits of the returns.

3. RETURN BASED STYLE ANALYSIS

In recent years return based Style Analysis, as introduced by William F. Sharpe 1992, has become a very popular tool for analysing fund returns. The reason behind this is that the information required for the analysis is reasonably easily obtained in contrast to the difficulties entailed in obtaining the desired information from the actual manager of a fund.

In essence, in return based Style Analysis a factor model is used to explain the fund returns. The factors are taken to be representative of a specific class of assets, for example, instruments that behave essentially the same. The purpose of the analysis is to determine a manager's effective asset mix with respect to a set of asset classes. In effect an attempt to determine the manager's exposure to changes in the related asset class and thereby achieving a better understanding of the funds behaviour. In order to accomplish this a set of style coefficients are calculated, one for each asset class. Each coefficient then corresponds to the exposure towards the asset class in question. These style attribution coefficients are calculated in such a way that the variance of the excess return of the manager over the style benchmarks becomes minimal. Essentially the problem is, mathematically speaking, one of performing a certain quadratic optimisation.

The final mathematical aspect that is worthy of note is the question of the uniqueness of the solution. It can be proven mathematically that there always exists exactly one set of style coefficients that fill the conditions mentioned above. The full proof of this is beyond the scope of this paper but I will supply a short summary for those so inclined:

Minimizing the variance of excess return of the manager over the style benchmark amounts to finding the shortest distance between a point and a convex set in a certain Euclidean space; it is true in every Euclidean space that this distance is assumed at exactly one point on the convex set. This is only true given that the point lies outside the convex set.

The only data required is historical NAV data on the funds to be included in the analysis as well as historical NAV data on suitable indices. Sharpe originally used monthly data due to the fact that it was more easily obtained and he considered it to yield sufficiently accurate results. I will however make use of daily data for the purpose of this analysis.

The classical return based Style Analysis has two main constraints, it assumes that all factor loadings (*regression coefficients which multiply with factors to produce measured variables according to the common factor model.*) are positive and that they sum to one. These factor loadings therefore constitute positively weighted portfolios and mutual returns can be decomposed in the return on the style portfolios and an idiosyncratic fund returns.

For the purpose of this analysis I will make use of the classical return based Style Analysis. This will yield the positively weighted style portfolio that is the closest to the fund analyzed, at least in the least square sense.

3.1. Theory

Sharpe's formula bears, mathematically speaking a strong resemblance to the classical constrained multivariate regression analysis. The question remain, are they the same? And if so, can I use classical multivariate regression analysis to perform a style analysis? The answers to these questions are no, and yes which I will illustrate with a simple example. For the purpose of this example I have arbitrarily chosen four factor indices, the actual number is irrelevant. F_r is the return of the fund, $A1_r$ to $A4_r$ represents the factor returns, c_1 to c_4 the style coefficients and r_1 to r_4 and α the coefficients and constant term in the multiple regression analysis.

Sharpe seeks to minimize the *variance* of the expression.

$F_r - (c_1A1_r + c_2A2_r + c_3A3_r + c_4A4_r)$

While classical multivariate regression analysis determines a constant α and coefficients *r1*, *r2*, *r3*, *r4* in such a way that the *sum of the squares* of the series

$F_r - (\alpha + r_1A1_r + r_2A2_r + r_3A3_r + r_4A4_r)$

is minimized.

If the regression is performed with alpha constrained to 0, then the expression above becomes the same that was used in Sharpe's method, but the quantity that gets minimized is different. In Sharpe's method, it is the *variance*, while in regression analysis it is the *sum of the squares*.

This shows that Sharpe's method and multivariate regression are simply two different methods with different intents. This illustrates the answers to the first question; no they are not the same.

However, there is a mathematical connection between the two. It can be proven (again, the fomal proof is beyond the scope of this paper) that the coefficients that minimize the *variance* of the expression:

$M - (c1A1 + c2A2 + c3A3 + c4A4)$

which happen to be the same ones that minimize the *sum of the squares* of the expression

$M - (\alpha + r1A1 + r2A2 + r3A3 + r4A4)$

Thus, the answer to the second question is yes and the following is true:

Performing a returns-based style analysis according to William F. Sharpe's method is equivalent to performing a classical multivariate linear regression with unconstrained alpha and then "dropping the alpha," in effect, considering only the regression coefficients.

It should be clear that this connection between Sharpe's method and classical regression analysis is rather accidental. The original intent of the two methods is different. Minimizing variance is different from minimizing the sum of the squares. It just so happens that under certain circumstances (unconstrained alpha), the coefficients come out to be the same.

The fact that it is possible to make use of multiple linear regression techniques in order to calculate the style coefficients solves a number of potential practical issues. It also allows us to use powerful software for analyzing the data and correcting for common issues known to arise when using financial data as basis for a time series analysis. The chosen method should yield accurate estimates as well as a good grasp of the accuracy of the model.

3.2. Potential issues

There are some potential issues that need be examined in order to obtain reliable results from a multiple regression analysis. One of the implicit assumptions that regression analysis is based upon is that the underlying time series are (weakly) stationary, defined as:

A stochastic process is considered to be weakly stationary if and only if its mean and variance is constant over time and the value of covariance between two periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed.

In essence, that they are time invariant. If this is not true, the time series is considered to be nonstationary. As all the classical tests, t-test, F-test etc., are based on this assumption it is essential to verify that it is valid. Informally, if a series is weakly stationery or not can be tested by the correleogram of a time series, it is basically a graph of autocorrelation at various lags.

3.2.1. Serial- and Autocorrelation

A common find in time series regressions is that the residuals are correlated with their own lagged values. This serial correlation violates the standard assumption of regression theory that disturbances are not correlated with other disturbances. The primary problems associated with serial correlation are:

Ordinary least squares, OLS, is no longer efficient among linear estimators. Furthermore, since prior residuals help to predict current residuals, it is possible to take advantage of this information to form a better prediction of the dependent variable. Standard errors computed using the textbook OLS formula are not correct, and are generally understated. If there are lagged dependent variables on the right-hand side, OLS estimates are biased and inconsistent.

A suitable test for first-order serial correlation is the Durbin-Watson, DW, statistic. It measures the linear association between adjacent residuals from a regression model. If there is no serial correlation the Durbin-Watson statistic will be around 2. The statistic will lie somewhere between 2 and 4 if there exist negative correlation. In case of positive serial correlation it will fall below two ranging down to zero in the worst-case scenario.

There are three main limitations of the DW test as a test for serial correlation. First, the distribution of the DW statistic under the null hypothesis depends on the data matrix . The usual approach to handling this problem is to place bounds on the critical region, creating a region where the test results are inconclusive. Second, if there are lagged dependent variables on the right-hand side of the regression, the DW test is no longer valid. Lastly, it only allows testing the null hypothesis of no serial correlation against the alternative hypothesis of first-order serial correlation.

Another test of serial correlation is the Q-statistic that overcomes these limitations, and are preferred in most applications. The correlogram-Q-statistics displays the autocorrelation and partial autocorrelation functions of the residuals, together with the Ljung-Box Q-statistics for high-order serial correlation. If there is no serial correlation in the residuals, the autocorrelations and partial autocorrelations at all lags should be nearly zero, and all Q-statistics should be insignificant with large p-values. This is the one I intend to use as indicator for the purpose of correcting for serial correlation.

3.3. Style Indices

The most important part of performing an accurate return based style analysis is the selection of the set of style indices. This choice should be made with great care as it may heavily influence the results. There are a number of factors to take into account in choosing style indices, I will elaborate on the most important ones. As I am using a modified multiple linear regression as the method of choice it is only natural that the number of style indices play a central role. If I chose too few indices the accuracy and reliability of the analysis suffer. I also risk an over-weighting of style portfolio weights relative to the fund being analysed due to the inadequate representation of the basic asset classes. If, however, to many style indices are selected I risk violating some of the fundamental underlying assumptions of style analysis. Namely that the returns need to be significantly different and the indices be mutually exclusive. The performance of an asset class should only be measured or reflected in one asset class index and not be included in another style index. If this is not the case the correlation between some of the style indices will by necessity be high. And if this is the case one should consider dropping some of the indices in order to diminish multicollinearity problems. In essence, mutually exclusive indices that cover the entire spectre of possible investments in the market segment pertinent to the analysis are needed.

3.4. Emerging Markets Factors

The term emerging markets is a rather vague concept but most commonly used to describe business and market activity in industrializing or emerging regions of the world, originally brought into fashion by in the 1980's by then World Bank economist Antoine van Agtmael. What it really signifies is a business phenomenon that is not fully described or constrained by geography or economic strength. Furthermore, politics matters at least as much as economics to the markets. Roughly it covers countries in a transitional phase between developing and developed status. Examples of emerging markets include China, India, much of Southeast Asia, countries in Eastern Europe and parts of Africa, Latin America and the Middle East.

Since the emerging markets sector is complex, vague and multifaceted I have chosen to perform the Style Analysis on four distinct categories to get as good a grasp as possible on the phenomena. The categories will be briefly motivated and explained below.

The factors used as basis for the analysis are drawn from the underlying Indices of the JP-Morgan EMBI Global Index that will be used as a control variable for the chosen method.

3.4.1 Instruments

The commercial banks are able to exchange their claims on developing countries into tradeable instruments thus reducing the concentration risk. There are three types of instruments that can be considered to be representative of the investment universe:

Brady Bonds

Dollardenominated bonds, issued originally by Latin American countries in the 1980's.
The structure was retained in later sovereign restructuring, for example Russia and Ecuador.

Eurobonds

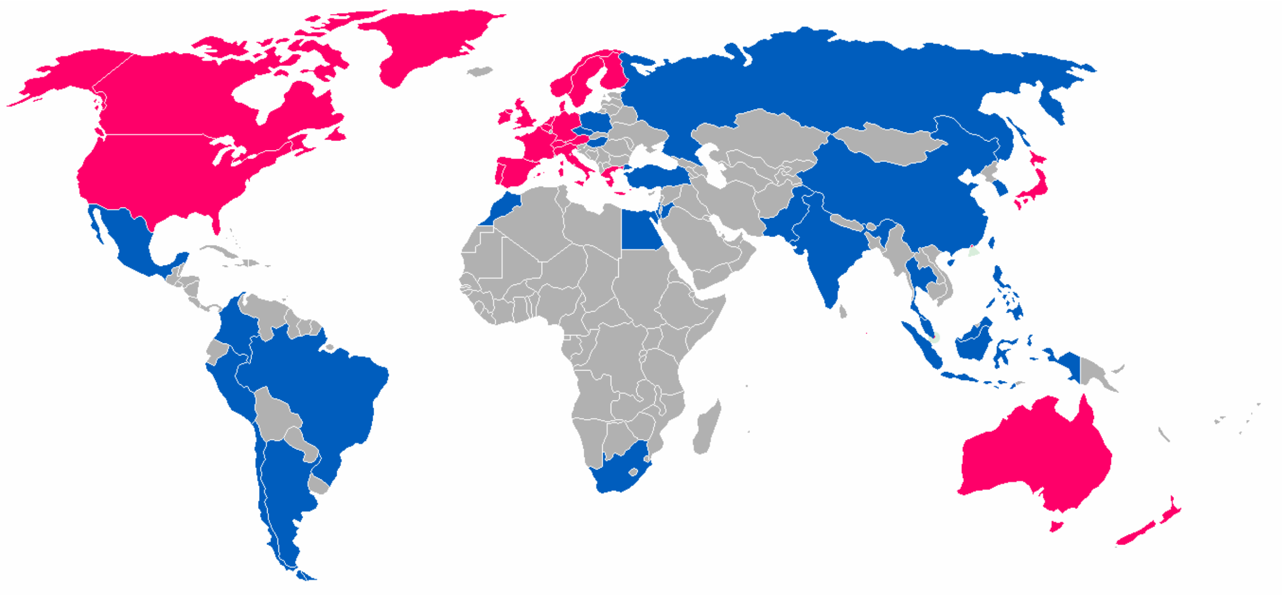
A broad class of bonds that has been issued in one countries currency but is traded outside of that country and in a different monetary system. Eurobonds are named after the currency they denominate, for example the Euroyen or Eurodollar.

Tradeable Loans

Bonds issued by the countries in question in the countries own currency in order to secure a loan, the bonds in question are tradeable.

3.4.2 Regions

As funds in the emerging markets sector is heavily dependent on the political stability as well as economic factors it would make sense to examine the regional investment style of the funds. There are five relevant regions to examine, Africa, Asia, Europe, Latin America and the Middle East. The names of these regions are a bit misleading as the actual countries involved is far fewer than implied. I have therefore included a graph giving a more accurate view. Countries marked in blue are emerging markets and pink are considered developed markets.



3.4.3 Durations

In the world of fixed income investment one of the main sources of risk is the duration exposure thus making it imperative to get a rough grasp on the duration exposure of the different funds to find an acceptable mix. The durations will be split into five sub-categories: 1-3 years, 3-5 years, 5-7 years, 7-10 years and 10 years and longer.

3.4.4 Credit ratings for countries

Another substantial source of risk in an emerging markets fund is in turn determined of the creditworthiness of the bonds it invests in. These are divided into the following four sub-categories, the ratings are according to Standard & Poor's rating system:

1. Investment grade, contains all bonds rated AAA to BBB

Non-investment grade split into:

2. BB-rated
3. B-rated
4. Residual ratings, bonds rated CCC and lower

3.5. High Yield Factors

High Yield bonds are fixed income products that share characteristics of both bonds and equities- As a result they perform differently than these securities making them a distinct separate asset class. Bonds rated BBB or higher are classed investment grade and BB and lower non-investment grade and are issued by companies as one way to raise capital. The High Yield focus on non-investment grade bonds with the potential for higher long-term returns than investment grade bonds. Another benefit is that such bonds are less sensitive to interest rates than other fixed income securities thus making it an ideal component in a fund of funds product. As stated above, the key feature of the High Yield sector is the credit ratings; generally speaking a lower rating implies higher risk and higher potential gain. Thus the investment universe is amply covered by credit ratings for companies as factors.

Also of interest, for the same reason as stated above, is the general duration exposure of the funds. Due to time constraints it has not been possible to secure suitable factor indices for this paper. A more complete analysis will be performed at a later date.

3.5.1 Credit ratings for companies

According to Standards & Poor´s ratings:

1. BB-rated
2. B-rated
3. CCC-rated and lower

4. COLLECTION OF DATA

Before any actual analysis can take place suitable historical data needs to be collected and thoroughly examined. What we need is a sufficiently large number of funds from both the High Yield and Emerging Market Debt segment of the market. We also need to find representative indices for both markets and factor indices for the Style Analysis. As I explained earlier, great care needs to be taken in choosing the factor indices.

The limits imposed have resulted in an initial total of 20 funds eligible to be included in the analysis. 8 respectively 7 funds from the High Yield and Emerging Market Debt asset class as well as 5 funds from the fixed income asset class. Regarding indices I concluded that the Emerging Market funds, with the exception of funds number 15 and 20, measured themselves against the JP Morgan EMBI Global index. The currency of those funds where also the same as the index. This index should work well as a base for the Style Analysis regarding Emerging Markets. This is however not the case for the funds within the High Yield sector. Almost every fund used a slightly different index as comparison and also hedged into different currencies depending on the base currency of the fund. I've chosen four indices that ought to cover most of the funds. The indexes chosen are listed below; they will be referred to as index 1-5:

1. JP Morgan EMBI Global Index
2. ML Global High Yield Index Constrained
3. ML US High Yield Master II Constrained Index
4. ML Euro High Yield Constrained Index
5. US HY Master II Index

All historical data has been taken from reliable sources reducing the potential problems concerning historical data. External indices and funds from JP Morgan's web based information site and Bloomberg's database. Historical data regarding internal funds has been supplied by Handelsbanken.

4.1. Corrections

After examining the funds a number of problems where identified that needed to be addressed. The major adjustments done where:

1. Funds that contain dividends at a regular interval
   Affects funds number 1, 2 and 3
2. Funds that have information logged on non trading days
   Affects funds number 1, 2, 3, 4 and 5
3. Fees subtracted from the funds
   Only relevant for funds number 1, 2, 3, 4 and 5
4. Funds that have switched currency during the chosen period
   Affects fund number 6
5. Funds with only limited historical information available, less than two years
   Affects funds number 10, 21, 22, and 25
6. Non-trading days occur on different dates in different countries
   Affects all funds

Since volatility and return fluctuate over time a yearly evaluation should yield more accurate results. Thus I've chosen to split the data into ten periods of one year each

This also enables an elegant solution to the first issue. The dividends paid out for funds 1, 2 and 3 happen on a yearly basis on a fixed interval that is identical for all three funds. By choosing the periods to coincide with the date of dividend payments I am able to solve the problem and get accurate results.

The second issue arises due to a monthly adjustment of NAV-values in some funds. These are always logged on the last day of the month even if that day is on a weekend or non-trading day. I've moved all such data to the first trading day before the non-trading day.

The third issue arises due to the fact that fees have been already been subtracted from the funds on a daily basis and needs to be reinserted in order to get an accurate view off historical return and volatility. Due to the fact that the purpose of this paper is to develop a product for SHB only the internal funds will have their fees reinserted. External funds will carry a similar if potentially lower fee for SHB so this is a reasonable approach to secure internally consistent estimates.

The fourth issue has been remedied by switching the currency back to the original currency, thus ignoring the currency change all together. This change only affects the period 2006-11-30 to 2006-12-30. This will of course have a slight impact on both the historical volatility and return of that fund for the affected period but as it only affects one week it is of no consequence. No change of currency has been made to the remaining data, 2007-01-01 and onward.

The fifth issue has been resolved by simply excluding those funds from the optimisation analysis. The reason is that the lack of data will result in misleading estimates and skew the results unacceptably. They will however be retained for the Style Analysis and the back testing phase of the development and will remain eligible for inclusion if deemed to be interesting on other basis.

The sixth and final issue has been adjusted for in the actual calculation of historical growth. All weekends have been removed for all funds as they occur simultaneously. The remaining non-trading days have been retained and logged as lost days in the calculation since no change of NAV occur on non-trading days. These lost days have then been subtracted from the total number of observations available yielding an accurate log of total trading days included in the analysis.

After adjustments 16 funds remain to be included in the optimisation analysis, 5 fixed income funds, 7 High Yield funds and 4 Emerging Market Funds as well as the original 20 for the purpose of the return based Style Analysis. This should be sufficient for the purpose of determining if this is a suitable model or not.

The actual names of the funds will be excluded from this paper and replaced with numbers. Number 1-5 refer to SHB:s own funds, number 6-13 to funds from the High Yield sector and number 14-20 to Emerging Market Debt funds. The reason for this is the sensitive nature of the project and the names are actually irrelevant to the results.

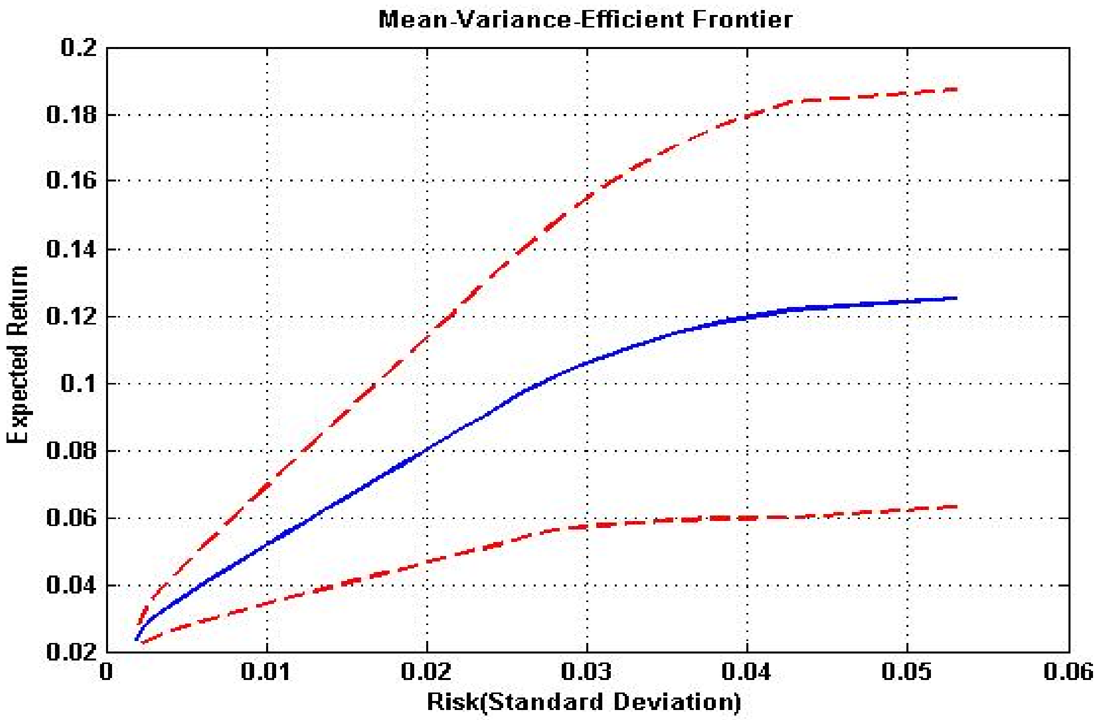
5. RESULTS AND ANALYSIS

5.1 The Efficient frontier

The program has been written to allow restrictions to be added if necessary. For the purpose of illustration an unrestricted weighted model has been used as a basis for the optimisation analysis. All available historical data of the funds has been included from 1997 to 2006 with no change made to the currency. This approach should yield a clear picture of whether the method is viable or not. Funds number 9, 14, 15 and 17 has been excluded from the optimisation analysis due to too short historical data, as previously mentioned. The resulting efficient frontier has been limited to show only the half of the parable that is of interest.

Below is a graph of the efficient frontier that illustrates all the possible optimal portfolio allocations as well as intervals indicating how accurate the estimates are, the intervals have been computed using a confidence level of 95%. The results below clearly illustrates that the estimates are within acceptable levels, the results from the optimisation seem satisfactory as well.

Graph 1.



5.1.1. Sample portfolio

I've chosen to illustrate the results with two potential portfolios taken from the efficient frontier combined with the relevant parts of the correlation matrix, displayed in table 1. Expected return with intervals and the estimated volatility for those portfolios are displayed in table 2. The complete correlation matrix as well as the historical yield and volatility of all funds have been included in the appendix under A1.1.

Table 1.

NR	2	3	6	7	10	16	19
2	1.00						
3	0.41	1.00					
6	0.14	0.03	1.00				
7	0.00	-0.01	0.47	1.00			
10	0.03	0.01	0.45	0.49	1.00		
16	0.25	0.05	0.31	0.14	0.36	1.00	
19	0.10	0.02	0.21	0.22	0.27	0.33	1.00
1	2%	47%	6%	17%	10%	10%	8%
2	4%	22%	9%	25%	15%	14%	11%
NR	Fixed Income		High Yield			Emerging Markets	
1	49%		34%			17%	
2	26%		49%			25%	

Table 2.

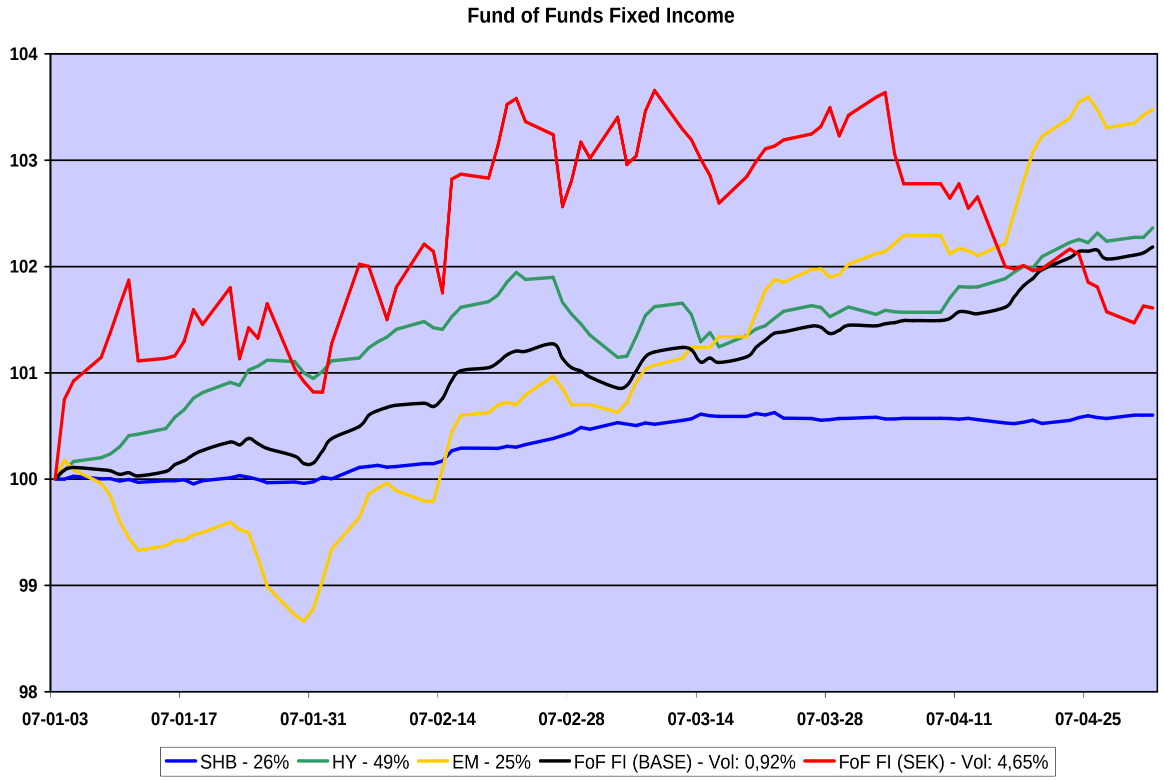
NR	Expected Return			Est. Volatility
1	3.86%	**6.20%**	8.53%	**1.36%**
2	4.62%	**7.95%**	11.28%	**1.98%**

In order to test the results I have created a portfolio using the weights in option number 2 above and simulated its development between 2007-01-03 until 2007-05-02. According to the analysis the expected return should be in the range 4.62%-11.28% and the volatility around 1.98% on a yearly basis.

In order to get a good grasp of the performance of the fund as well as the reason behind it I've chosen to create a graph that contains the following:

Sample portfolio in base currencies (black), in Swedish Krona (red), the different component sectors, High Yield (green), Emerging Markets (yellow) and Fixed Income (blue). The graphs of the components have been constructed by using the same weights as those used in the portfolio, recalculated to a base value of 100 for sake of comparison.

Graph 2.



The product is relatively stable as expected, however all funds included are denominated in their individual base currency. This means that the fund has a large exposure to currency fluctuations as 34% respectively 40% of the total value is denominated in Euro respectively US Dollar. As illustrated by the portfolio where all funds have been recalculated using Swedish Krona as base currency the impact of the volatile exchange rates is severe. The portfolio volatility rises from 0.92% to 4.65% at the same time as the return drops from 2.18% to 1.61%. This simple example clearly illustrates the need of a hedged portfolio.

The High Yield sector is the main component of the portfolio with a total weight of 49%. The Emerging Market sector represents 25% of the portfolio and is by far the most volatile but also generates a far higher return then the other components during the period. The remaining 26% has been invested in Swedish fixed income funds and form a low risk base for the portfolio balancing the higher volatility of the Emerging Markets sector.

5.2 Style analysis

As method I’ve used a standard least squares regression without a constant and used a generous inclusion limit, p-value below 10% rather than the customary 5% limit. In order to establish whether the model is valid or not I’ve used the adjusted R-squared value as a rough control of the validity of the model.

As expected the data suffered from serious problems caused by serial correlation. This has been corrected for by modifying the least square model using the appropriate auto regressive terms. In the final models no significant serial correlation remains and the resulting style coefficients can be considered to be reliable. I have also verified the method by performing the same analysis on the index itself and compared it with the stated index weights, receiving very satisfactory results. All the results can be found in the appendix, under A2.5.

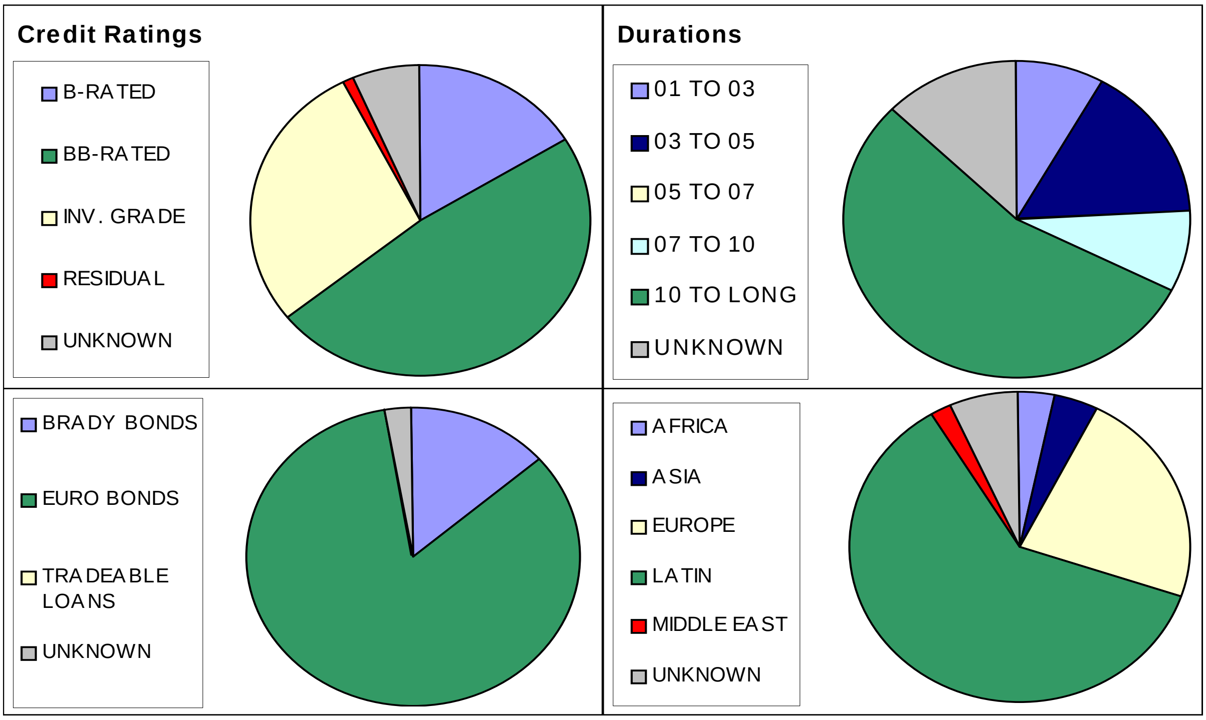
I have however realised that an important part of the investment universe is missing. I’ve neglected to include an index that simulates the behaviour of cash. Thus, if a fund holds a portion of its assets in cash, the analysis will fail to pick up on this.

The results from the analysis of funds within the High Yield sector were unsatisfactory. Even though four separate indices where included I have most likely failed to capture the relevant investment universe for most of the funds. This will apparently require a great deal more study in order to identify the necessary factor indices and determine the difference between them.

As the results from the analysis of the High Yield Funds where highly unreliable I only managed to get satisfactory results regarding one fund. This is naturally not enough to generate a correct view of the funds exposure with respect to the High Yield sector. In order for the model to be of practical value these issues have to be rectified.

5.2.1. Results

The return based Style Analysis of the Emerging Markets funds yielded mostly satisfactory results. The adjusted R2-value for funds number 15, 17 and 20 where too low for the results to be considered reliable and have been excluded from the analysis. The information gathered gives an overview of the chosen portfolios exposure towards the Emerging Markets sector, illustrated by the graphs below. As mentioned before, an index simulating cash holdings will need to be found and incorporated in the model for it to be complete as illustrated by the relatively large unexplained source of return. Also of interest is to find more indices covering the emerging market sector in order to be able to analyse the remaining funds correctly.



6. CONCLUSIONS

The combination of portfolio optimisation theory and return based Style Analysis seems to form a promising analytical basis for the new product. The results from the optimisation analysis should generate an optimally diversified product with respect to total risk exposure. Even though the accuracy of the estimates of the expected return is still in question they ought to be internally consistent and point in the right direction. In order to enhance the accuracy of the model they should be augmented with a forecast analysis of the market segments as well as a separate analysis of the individual internal funds. The results gathered so far from the Style Analysis are reliable but incomplete, especially regarding the High Yield sector. They do however still serve the purpose of illustrating the fact that return based Style Analysis is a viable method of securing an independent source of information. For the approach to be viable it will be necessary to secure the missing factor indices in order to completely cover the investment universe for the Emerging Markets and High Yield sector.

7. REFERENCES

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[2] William F. Sharpe, “Asset Allocation: Management Style and Performance Measurement,” The Journal Of Portfolio Management, 18 (1992), pp. 7 – 19

[3] T. Daniel Coggin and Frank J. Fabozzi, (Eds.), The Handbook of Equity Style Management, Third Edition, John Wiley & Sons, New York, pp. 435–453 (2003)

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A. APPENDIX

A2. Results from the Optimisation Analysis

A1.1. Correlation matrix

NR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1,00																			
2	0,85	1,00																		
3	0,37	0,41	1,00																	
4	0,22	0,23	0,34	1,00																
5	0,64	0,70	0,25	0,32	1,00															
6	0,13	0,14	0,03	0,03	0,11	1,00														
7	-0,01	0,00	-0,01	0,01	0,00	0,47	1,00													
8	0,07	0,06	0,04	0,07	0,14	0,19	0,36	1,00												
9	0,13	0,13	0,05	0,03	0,11	0,34	0,33	0,27	1,00											
10	0,02	0,03	0,01	0,08	0,00	0,45	0,49	0,31	0,40	1,00										
11	-0,01	0,02	0,01	0,01	0,02	0,21	0,33	0,14	0,06	0,24	1,00									
12	0,02	0,01	0,01	0,07	0,02	0,24	0,32	0,29	0,17	0,33	0,25	1,00								
13	0,00	-0,01	-0,02	0,05	0,02	0,36	0,50	0,46	0,27	0,56	0,31	0,47	1,00							
14	0,07	0,08	0,03	0,07	0,18	0,19	0,25	0,36	0,33	0,20	0,10	0,23	0,29	1,00						
15	-0,05	-0,04	0,05	0,00	0,01	0,27	0,24	0,20	0,25	0,19	0,07	0,18	0,17	0,76	1,00					
16	0,21	0,25	0,05	0,06	0,21	0,31	0,14	0,08	0,45	0,36	0,01	0,08	0,13	0,28	0,19	1,00				
17	0,07	0,08	0,01	-0,01	0,07	0,26	0,27	0,15	0,45	0,34	0,02	0,11	0,19	0,38	0,29	0,67	1,00			
18	0,12	0,12	0,07	0,05	0,09	0,17	0,14	0,05	0,23	0,27	0,05	0,09	0,15	0,20	0,17	0,51	0,51	1,00		
19	0,09	0,10	0,02	0,05	0,18	0,21	0,22	0,32	0,17	0,27	0,13	0,22	0,35	0,64	0,41	0,33	0,24	0,19	1,00	
20	0,12	0,15	0,01	0,02	0,19	0,26	0,28	0,23	0,38	0,27	0,05	0,14	0,19	0,73	0,74	0,47	0,62	0,33	0,47	1,00

A1.2. Yield and volatility of funds

	1		2		3		4		5	
Year	**Yield**	**Volatility**	**Yield**	**Volatility**	**Yield**	**Volatility**	**Yield**	**Volatility**	**Yield**	**Volatility**
1997	4.22%	1.27%	7.12%	3.93%	3.11%	0.38%	0.00%	0.00%	0.00%	0.00%
1998	8.73%	2.51%	11.98%	3.51%	4.18%	0.49%	0.00%	0.00%	0.00%	0.00%
1999	0.24%	2.94%	-0.68%	3.95%	2.45%	0.31%	2.14%	0.39%	-2.42%	3.58%
2000	6.35%	2.57%	6.95%	3.10%	3.68%	0.56%	3.28%	0.28%	3.17%	2.93%
2001	4.43%	4.68%	4.63%	3.12%	3.80%	0.31%	4.11%	0.40%	7.76%	3.13%
2002	4.57%	2.25%	5.08%	2.99%	3.90%	0.27%	2.92%	0.36%	5.01%	3.82%
2003	3.77%	2.89%	3.85%	3.82%	2.84%	0.23%	2.27%	0.22%	4.01%	4.23%
2004	5.54%	1.72%	6.82%	2.65%	2.14%	0.17%	1.73%	0.17%	6.80%	2.84%
2005	3.69%	1.87%	4.76%	2.67%	1.69%	0.15%	1.50%	0.17%	4.21%	3.17%
2006	1.43%	1.64%	1.35%	2.19%	1.72%	0.15%	2.17%	0.16%	1.10%	3.19%
Estimated	**3.51%**	**2.23%**	**4.11%**	**2.81%**	**2.41%**	**0.25%**	**2.26%**	**0.23%**	**3.45%**	**3.24%**

	14		15		16		17		18	
Year	**Yield**	**Volatility**	**Yield**	**Volatility**	**Yield**	**Volatility**	**Yield**	**Volatility**	**Yield**	**Volatility**
1997	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1998	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-25.08%	24.19%
1999	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	22.25%	14.33%
2000	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	13.63%	7.72%
2001	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9.88%	12.31%
2002	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.30%	9.17%
2003	0.00%	0.00%	0.00%	0.00%	28.22%	7.74%	0.00%	0.00%	21.87%	5.70%
2004	0.00%	0.00%	0.00%	0.00%	10.73%	7.22%	0.00%	0.00%	12.53%	6.28%
2005	7.29%	4.25%	0.00%	0.00%	10.68%	5.16%	11.24%	5.32%	12.33%	4.80%
2006	9.52%	4.44%	4.94%	8.57%	9.69%	4.04%	11.90%	3.85%	9.91%	3.80%
Estimated	**8.86%**	**4.27%**	**5.17%**	**8.38%**	**12.52%**	**5.30%**	**11.91%**	**4.28%**	**11.44%**	**7.84%**

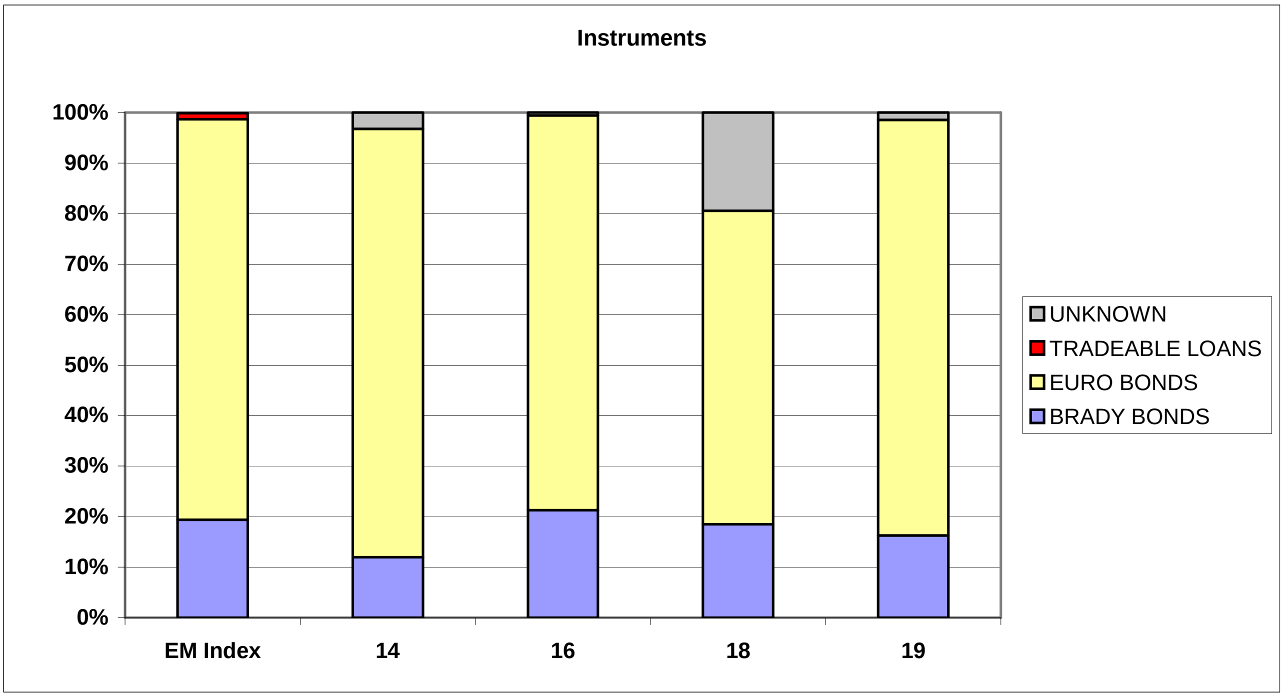
	19		20	
Year	**Yield**	**Volatility**	**Yield**	**Volatility**
1997	0.00%	0.00%	0.00%	0.00%
1998	0.00%	0.00%	0.00%	0.00%
1999	0.00%	0.00%	0.00%	0.00%
2000	0.00%	0.00%	0.00%	0.00%
2001	0.00%	0.00%	0.00%	0.00%
2002	0.00%	0.00%	0.00%	0.00%
2003	18.12%	7.11%	0.00%	0.00%
2004	11.00%	8.43%	4.08%	6.39%
2005	11.55%	5.24%	10.76%	5.71%
2006	10.32%	4.12%	10.80%	5.70%
Estimated	**11.83%**	**5.41%**	**9.65%**	**5.72%**

	6		7		8		9		10	
Year	Yield	Volatility	Yield	Volatility	Yield	Volatility	Yield	Volatility	Yield	Volatility
1997	0	0	0	0	0	0	0	0	0	0
1998	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
1999	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
2000	-1,30%	2,29%	-3,33%	3,22%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
2001	5,99%	6,60%	5,35%	6,62%	0,00%	0,00%	0,00%	0,00%	0,01%	4,38%
2002	0,40%	4,93%	1,26%	3,99%	0,00%	0,00%	0,00%	0,00%	0,85%	3,95%
2003	23,97%	4,34%	18,33%	2,34%	0,00%	0,00%	0,00%	0,00%	19,17%	3,32%
2004	17,02%	4,91%	13,56%	2,65%	5,45%	2,70%	0,00%	0,00%	9,87%	3,56%
2005	-2,98%	4,51%	5,50%	3,56%	1,89%	2,23%	0,41%	2,37%	1,71%	2,62%
2006	15,36%	3,83%	8,86%	1,56%	3,88%	1,38%	10,76%	2,01%	9,62%	1,56%
Estimated	10,29%	4,30%	8,27%	3,00%	3,74%	1,87%	7,25%	2,08%	7,77%	2,72%

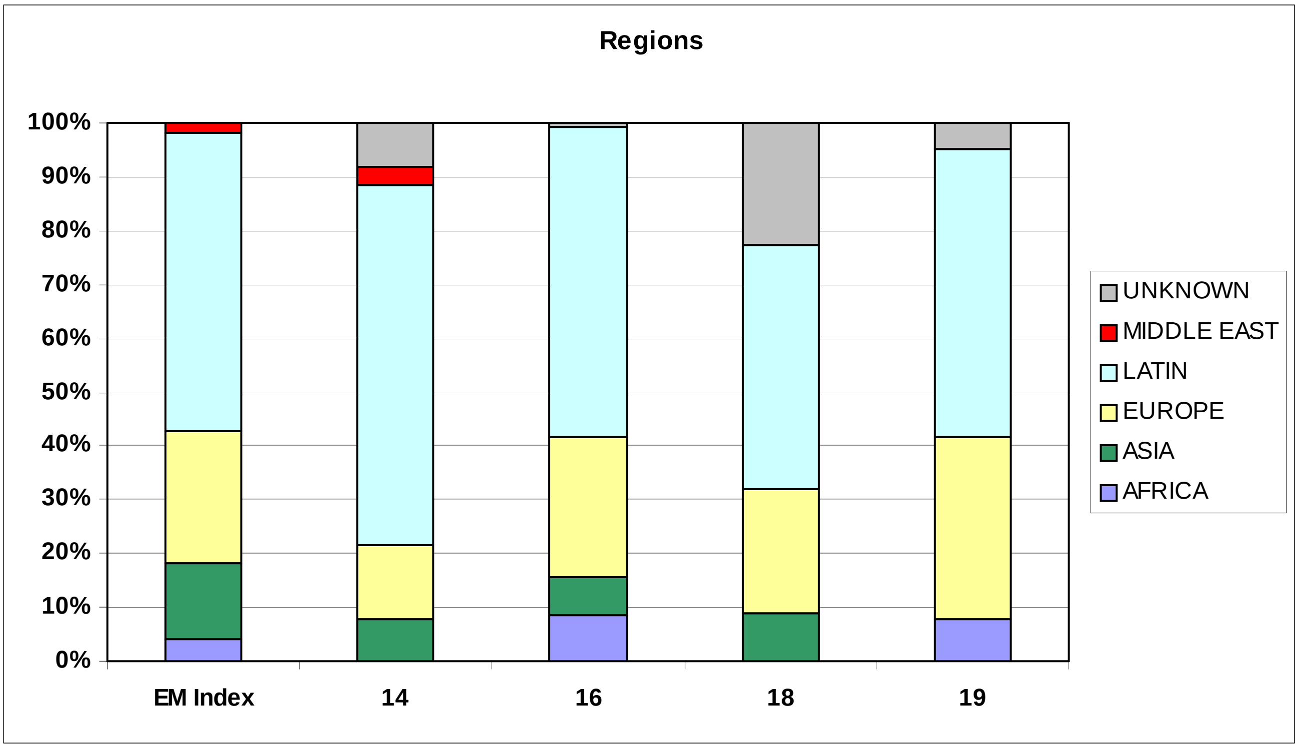
	11		12		13	
Year	Yield	Volatility	Yield	Volatility	Yield	Volatility
1997	0	0	0	0	0	0
1998	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
1999	12,60%	4,84%	2,59%	2,96%	0,00%	0,00%
2000	-14,61%	7,36%	-13,45%	5,62%	-3,15%	5,07%
2001	-15,98%	13,28%	5,65%	6,07%	3,26%	6,61%
2002	-18,10%	9,59%	-5,02%	5,83%	0,55%	4,72%
2003	22,72%	12,18%	20,56%	3,57%	18,01%	3,31%
2004	8,61%	5,22%	8,06%	3,60%	8,21%	3,14%
2005	3,39%	4,40%	0,56%	3,63%	2,16%	3,30%
2006	4,92%	2,43%	6,70%	2,78%	6,07%	1,67%
Estimated	3,18%	6,48%	4,88%	3,68%	5,75%	3,27%

A2. Results from the Style Analysis

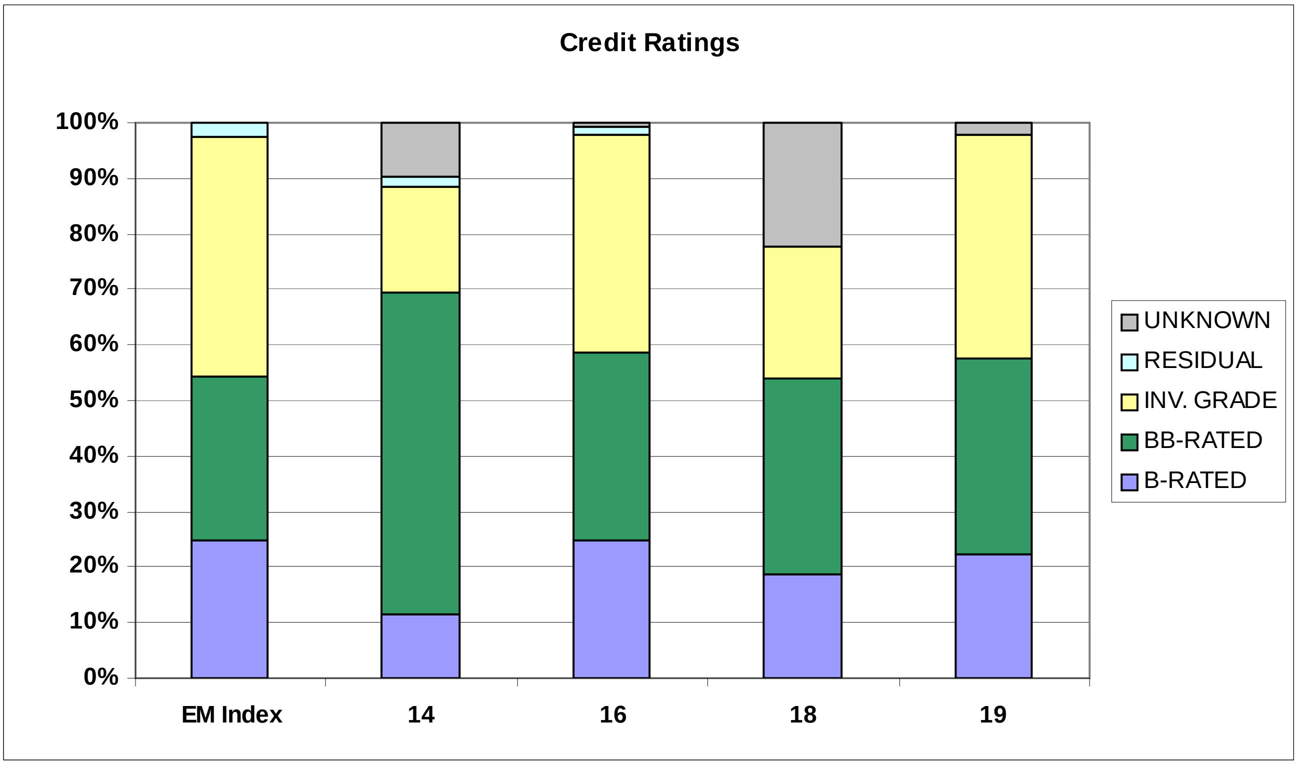
A2.1. Emerging Markets, Instruments



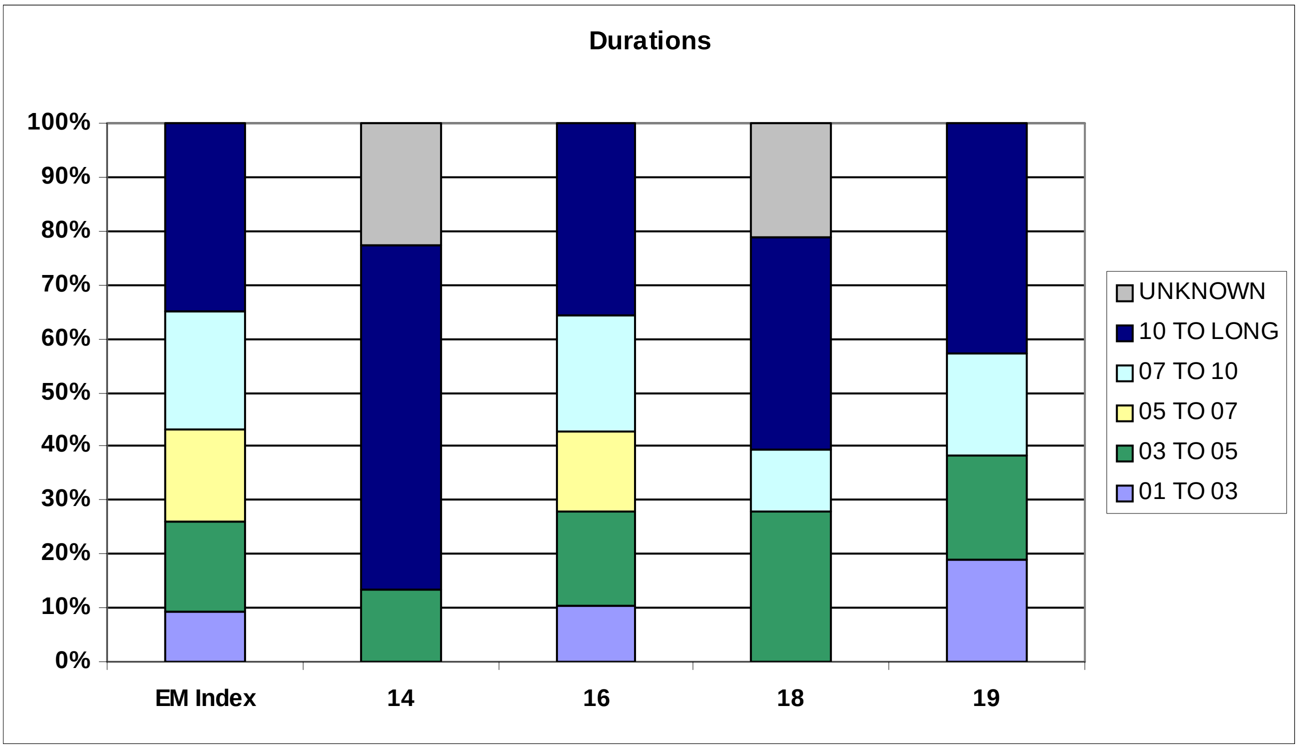
A2.2. Emerging Markets, Regions



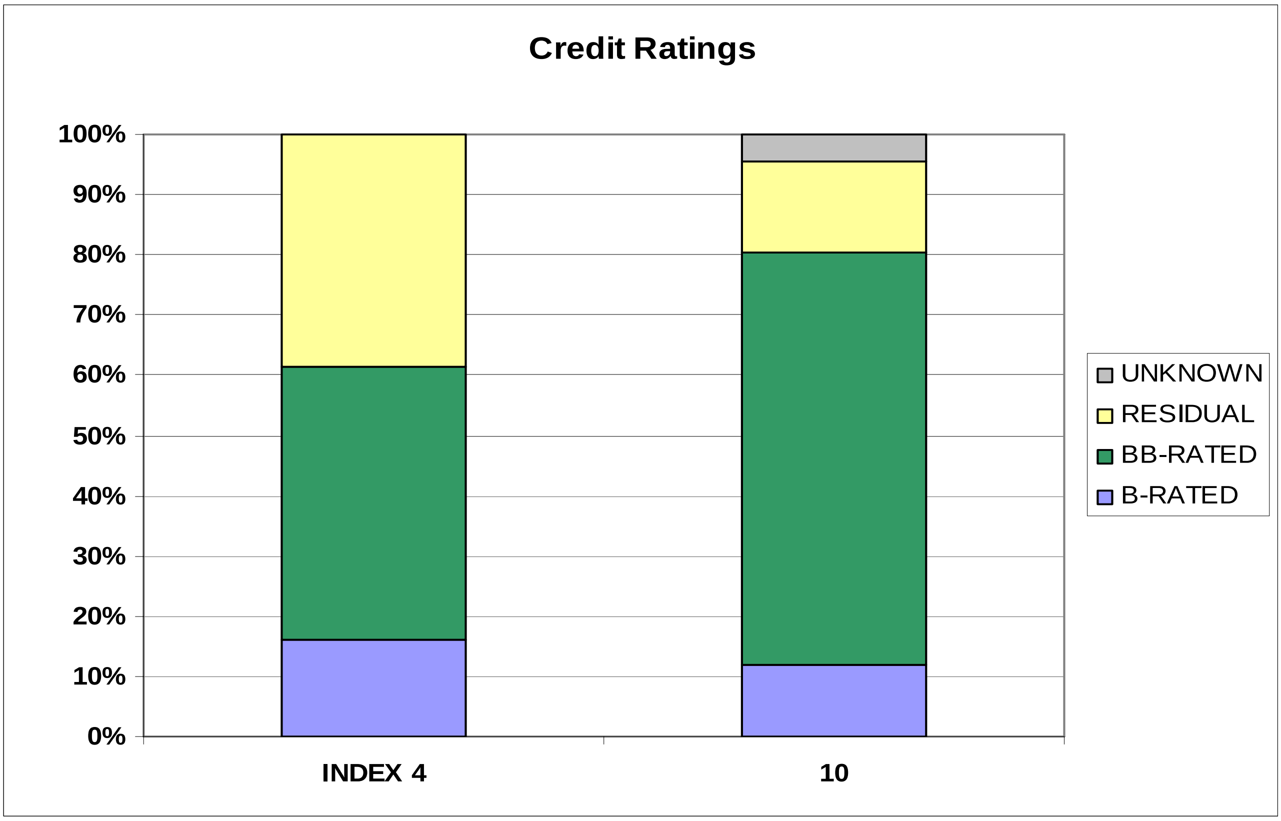
A2.3. Emerging Markets, Credit Ratings



A2.4. Emerging Markets, Durations



A2.5. High Yield, Credit Ratings



A3. Results from the regression analysis

A3.1. Index 1

Dependent Variable: Index 1
Method: Least Squares
Date: 05/13/07 Time: 15:03
Sample (adjusted): 20 1089
Included observations: 1070 after adjustments
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRADY	0.19	0.00	158.63	-
EURO	0.79	0.00	538.09	-
LOAN	0.01	0.00	26.83	0.00
AR(3)	- 0.08	0.03	- 2.59	0.01
AR(19)	0.08	0.03	2.79	0.01

R-squared	1.00	Mean dependent var	0.05
Adjusted R-squared	1.00	S.D. dependent var	0.35
S.E. of regression	0.01	Akaike info criterion	- 7.10
Sum squared resid	0.05	Schwarz criterion	- 7.08
Log likelihood	3,805	Durbin-Watson stat	2.02

Inverted AR Roots	0.87	.82-.29i	.82+.29i	.69+.54i
	.69-.54i	.48-.74i	.48+.74i	.22+.85i
	.22-.85i	-.07+.87i	-.07-.87i	-.35+.80i
	-.35-.80i	-.59-.64i	-.59+.64i	-.77-.41i
	-.77+.41i	-.87+.14i	-.87-.14i	

Dependent Variable: Index 1
Method: Least Squares
Date: 05/13/07 Time: 15:11
Sample (adjusted): 3 1089
Included observations: 1087 after adjustments
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CREDIT_B_INDEX	0.25	0.00	84.34	-
CREDIT_BB_INDEX	0.30	0.01	57.57	-
CREDIT_INV_GRADE	0.44	0.01	83.35	-
CREDIT_RESIDUAL_INDEX	0.03	0.00	15.22	0.00
AR(2)	0.07	0.03	2.46	0.01

R-squared	0.99	Mean dependent var	0.05
Adjusted R-squared	0.99	S.D. dependent var	0.35
S.E. of regression	0.04	Akaike info criterion	- 3.83
Sum squared resid	1.37	Schwarz criterion	- 3.80
Log likelihood	2,085	Durbin-Watson stat	1.92

Inverted AR Roots	0.27	- 0.27

Dependent Variable: Index 1
Method: Least Squares
Date: 05/13/07 Time: 15:08
Sample (adjusted): 4 1089
Included observations: 1086 after adjustments
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AFRICA	0.04	0.00	39.41	0.00
ASIA	0.14	0.00	128.75	-
EUROPE	0.25	0.00	283.24	-
LATIN	0.56	0.00	744.21	-
MIDDLE_EAST	0.02	0.00	25.07	0.00
AR(1)	0.13	0.03	4.42	0.00
AR(3)	0.07	0.03	2.35	0.02

R-squared	1.00	Mean dependent var	0.05
Adjusted R-squared	1.00	S.D. dependent var	0.35
S.E. of regression	0.01	Akaike info criterion	- 7.10
Sum squared resid	0.05	Schwarz criterion	- 7.07
Log likelihood	3,864	Durbin-Watson stat	1.99

Inverted AR Roots	0.46	-.16-.35i	-.16+.35i

Dependent Variable: Index 1
Method: Least Squares
Date: 05/13/07 Time: 15:20
Sample (adjusted): 2 1089
Included observations: 1088 after adjustments
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_01_TO_03	0.10	0.02	5.62	0.00
_03_TO_05	0.17	0.02	9.81	0.00
_05_TO_07	0.18	0.01	12.44	0.00
_07_TO_10	0.23	0.01	19.95	0.00
_10_TO_LONG	0.36	0.01	46.93	0.00
AR(1)	0.08	0.03	2.61	0.01

R-squared	0.98	Mean dependent var	0.05
Adjusted R-squared	0.98	S.D. dependent var	0.35
S.E. of regression	0.05	Akaike info criterion	- 3.30
Sum squared resid	2.33	Schwarz criterion	- 3.27
Log likelihood	1,800	Durbin-Watson stat	1.98

Inverted AR Roots	0.08

A3.2. Fund 14

Dependent Variable: Fund nr. 14
Method: Least Squares
Date: 05/12/07 Time: 15:31
Sample (adjusted): 9 500
Included observations: 492 after adjustments
Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EURO	0.85	0.05	18.49	0.00
BRADY	0.12	0.04	3.39	0.00
AR(1)	- 0.20	0.05	- 4.32	0.00
AR(2)	- 0.11	0.04	- 2.51	0.01
AR(8)	0.12	0.04	2.64	0.01

R-squared	0.78	Mean dependent var	0.04
Adjusted R-squared	0.78	S.D. dependent var	0.25
S.E. of regression	0.12	Akaike info criterion	- 1.44
Sum squared resid	6.71	Schwarz criterion	- 1.39
Log likelihood	358.33	Durbin-Watson stat	1.97

Inverted AR Roots	0.73	.50+.55i	.50-.55i	-.03+.78i
	-.03-.78i	-.55+.55i	-.55-.55i	- 0.77

Dependent Variable: Fund nr. 14
Method: Least Squares
Date: 05/12/07 Time: 15:49
Sample (adjusted): 3 500
Included observations: 498 after adjustments
Convergence achieved after 8 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CREDIT_B_INDEX	0.11	0.02	5.62	0.00
CREDIT_BB_INDEX	0.58	0.03	17.53	0.00
CREDIT_RESIDUAL_INDEX	0.02	0.01	3.26	0.00
CREDIT_INV_GRADE	0.19	0.03	6.24	0.00
AR(1)	- 0.30	0.05	- 6.52	0.00
AR(2)	- 0.14	0.04	- 3.19	0.00

R-squared	0.80	Mean dependent var	0.04
Adjusted R-squared	0.80	S.D. dependent var	0.25
S.E. of regression	0.11	Akaike info criterion	- 1.53
Sum squared resid	6.17	Schwarz criterion	- 1.48
Log likelihood	386.84	Durbin-Watson stat	1.98

Inverted AR Roots	-.15+.35i	-.15-.35i

Dependent Variable: Fund nr. 14
Method: Least Squares
Date: 05/12/07 Time: 15:41
Sample (adjusted): 9 500
Included observations: 492 after adjustments
Convergence achieved after 8 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ASIA	0.08	0.04	2.12	0.03
EUROPE	0.14	0.03	3.95	0.00
LATIN	0.67	0.03	23.39	0.00
MIDDLE_EAST	0.03	0.02	1.95	0.05
AR(1)	- 0.22	0.05	- 4.74	0.00
AR(2)	- 0.12	0.05	- 2.59	0.01
AR(8)	0.11	0.04	2.49	0.01

R-squared	0.79	Mean dependent var	0.04
Adjusted R-squared	0.79	S.D. dependent var	0.25
S.E. of regression	0.11	Akaike info criterion	- 1.48
Sum squared resid	6.37	Schwarz criterion	- 1.42
Log likelihood	371.16	Durbin-Watson stat	1.97

Inverted AR Roots	0.72	.50-.54i	.50+.54i	-.03-.77i
	-.03+.77i	-.55-.55i	-.55+.55i	- 0.77

Dependent Variable: Fund nr. 14
Method: Least Squares
Date: 05/12/07 Time: 15:58
Sample (adjusted): 9 500
Included observations: 492 after adjustments
Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_03_TO_05	0.13	0.08	1.64	0.10
_10_TO_LONG	0.64	0.02	26.64	0.00
AR(1)	- 0.23	0.05	- 4.95	0.00
AR(2)	- 0.12	0.05	- 2.55	0.01
AR(8)	0.12	0.04	2.68	0.01

R-squared	0.78	Mean dependent var	0.04
Adjusted R-squared	0.78	S.D. dependent var	0.25
S.E. of regression	0.12	Akaike info criterion	- 1.45
Sum squared resid	6.60	Schwarz criterion	- 1.41
Log likelihood	362.35	Durbin-Watson stat	1.97

Inverted AR Roots	0.72	.50-.55i	.50+.55i	-.03-.78i
	-.03+.78i	-.56+.55i	-.56-.55i	- 0.77

A3.3. Fund 16

Dependent Variable: Fund nr. 16
Method: Least Squares
Date: 05/12/07 Time: 16:56
Sample (adjusted): 6 1089
Included observations: 1084 after adjustments
Convergence achieved after 13 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EURO	0.78	0.03	26.65	0.00
BRADY	0.21	0.03	8.51	0.00
AR(1)	-0.31	0.03	-10.11	0.00
AR(2)	-0.17	0.03	-5.62	0.00
AR(3)	-0.07	0.03	-2.25	0.02
AR(5)	0.10	0.03	3.40	0.00

R-squared	0.83	Mean dependent var	0.06
Adjusted R-squared	0.83	S.D. dependent var	0.36
S.E. of regression	0.15	Akaike info criterion	-0.95
Sum squared resid	24.39	Schwarz criterion	-0.92
Log likelihood	518.45	Durbin-Watson stat	2.01

Inverted AR Roots	0.51	.13+.66i	.13-.66i	-.54-.37i
	-.54+.37i			

Dependent Variable: Fund nr. 16
Method: Least Squares
Date: 05/12/07 Time: 17:17
Sample (adjusted): 6 1089
Included observations: 1084 after adjustments
Convergence achieved after 11 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CREDIT_RESIDUAL_INDEX	0.02	0.01	2.16	0.03
CREDIT_INV_GRADE	0.39	0.02	17.99	0.00
CREDIT_BB_INDEX	0.34	0.02	15.80	0.00
CREDIT_B_INDEX	0.25	0.01	20.03	0.00
AR(1)	-0.22	0.03	-7.37	0.00
AR(2)	-0.10	0.03	-3.37	0.00
AR(5)	0.12	0.03	4.11	0.00

R-squared	0.82	Mean dependent var	0.06
Adjusted R-squared	0.82	S.D. dependent var	0.36
S.E. of regression	0.15	Akaike info criterion	-0.90
Sum squared resid	25.45	Schwarz criterion	-0.87
Log likelihood	495.19	Durbin-Watson stat	2.02

Inverted AR Roots	0.59	.15-.6	.15+.64i	-.55+.40i
	-.55-.40i			

Dependent Variable: Fund nr. 16
Method: Least Squares
Date: 05/12/07 Time: 16:58
Sample (adjusted): 6 1089
Included observations: 1084 after adjustments
Convergence achieved after 13 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AFRICA	0.09	0.02	3.90	0.00
ASIA	0.07	0.02	3.26	0.00
EUROPE	0.26	0.02	14.11	0.00
LATIN	0.58	0.01	38.99	0.00
AR(1)	-0.33	0.03	-10.75	0.00
AR(2)	-0.20	0.03	-6.23	0.00
AR(3)	-0.08	0.03	-2.70	0.01
AR(5)	0.08	0.03	2.78	0.01

R-squared	0.84	Mean dependent var	0.06
Adjusted R-squared	0.84	S.D. dependent var	0.36
S.E. of regression	0.15	Akaike info criterion	-0.99
Sum squared resid	23.19	Schwarz criterion	-0.96
Log likelihood	545.68	Durbin-Watson stat	2.01

Inverted AR Roots	0.47	.12+.65i	.12-.65i	-.52-.35i
	-.52+.35i			

Dependent Variable: Fund nr. 16
Method: Least Squares
Date: 05/12/07 Time: 17:20
Sample (adjusted): 6 1089
Included observations: 1084 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_10_TO_LONG	0.37	0.02	15.23	0.00
_07_TO_10	0.22	0.04	6.13	0.00
_05_TO_07	0.15	0.05	3.25	0.00
_03_TO_05	0.18	0.06	3.08	0.00
_01_TO_03	0.11	0.06	1.91	0.06
AR(1)	-0.27	0.03	-8.86	0.00
AR(2)	-0.13	0.03	-4.45	0.00
AR(5)	0.09	0.03	3.18	0.00

R-squared	0.82	Mean dependent var	0.06
Adjusted R-squared	0.82	S.D. dependent var	0.36
S.E. of regression	0.16	Akaike info criterion	-0.87
Sum squared resid	26.21	Schwarz criterion	-0.83
Log likelihood	479.36	Durbin-Watson stat	2.02

Inverted AR Roots	0.54	.12-.6	.12+.62i	-.52+.39i
	-.52-.39i			

A3.4. Fund 18

Dependent Variable: Fund nr. 18
Method: Least Squares
Date: 05/13/07 Time: 00:24
Sample: 1 1089
Included observations: 1089

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EURO	0.62	0.03	21.85	0.00
BRADY	0.19	0.02	7.93	0.00

R-squared	0.81	Mean dependent var	0.06
Adjusted R-squared	0.81	S.D. dependent var	0.31
S.E. of regression	0.14	Akaike info criterion	- 1.16
Sum squared resid	19.90	Schwarz criterion	- 1.15
Log likelihood	634.00	Durbin-Watson stat	2.10

Dependent Variable: Fund nr. 18
Method: Least Squares
Date: 05/13/07 Time: 00:32
Sample (adjusted): 6 1089
Included observations: 1084 after adjustments
Convergence achieved after 9 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CREDIT_B_INDEX	0.19	0.01	17.09	0.00
CREDIT_BB_INDEX	0.35	0.02	18.30	0.00
CREDIT_INV_GRADE	0.24	0.02	12.46	0.00
CREDIT_RESIDUAL_INDE	0.04	0.01	6.57	0.00
AR(1)	- 0.06	0.03	- 2.00	0.05
AR(5)	0.10	0.03	3.16	0.00

R-squared	0.83	Mean dependent var	0.06
Adjusted R-squared	0.82	S.D. dependent var	0.31
S.E. of regression	0.13	Akaike info criterion	- 1.21
Sum squared resid	18.65	Schwarz criterion	- 1.19
Log likelihood	663.78	Durbin-Watson stat	2.00

Inverted AR Roots	0.61	.18+.5	.18-.59i	-.52-.37i
	-.52+.37i			

Dependent Variable: Fund nr. 18
Method: Least Squares
Date: 05/13/07 Time: 00:29
Sample: 1 1089
Included observations: 1089

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ASIA	0.09	0.02	4.34	0.00
EUROPE	0.23	0.02	14.13	0.00
LATIN	0.45	0.01	31.11	0.00

R-squared	0.81	Mean dependent var	0.06
Adjusted R-squared	0.81	S.D. dependent var	0.31
S.E. of regression	0.14	Akaike info criterion	- 1.16
Sum squared resid	19.86	Schwarz criterion	- 1.15
Log likelihood	635.10	Durbin-Watson stat	2.09

Dependent Variable: Fund nr. 18
Method: Least Squares
Date: 05/13/07 Time: 00:37
Sample (adjusted): 6 1089
Included observations: 1084 after adjustments
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_03_TO_05	0.28	0.04	6.66	0.00
_07_TO_10	0.11	0.03	3.46	0.00
_10_TO_LONG	0.40	0.02	17.93	0.00
AR(2)	- 0.06	0.03	- 2.08	0.04
AR(5)	0.09	0.03	3.09	0.00

R-squared	0.81	Mean dependent var	0.06
Adjusted R-squared	0.81	S.D. dependent var	0.31
S.E. of regression	0.14	Akaike info criterion	- 1.12
Sum squared resid	20.56	Schwarz criterion	- 1.09
Log likelihood	610.81	Durbin-Watson stat	2.04

Inverted AR Roots	0.60	.19+.6	.19-.61i	-.49-.38i
	-.49+.38i			

A3.5. Fund 19

Dependent Variable: Fund nr. 19
Method: Least Squares
Date: 05/12/07 Time: 16:36
Sample (adjusted): 12 1050
Included observations: 1039 after adjustments
Convergence achieved after 13 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EURO	0.82	0.03	25.31	0.00
BRADY	0.16	0.03	5.78	0.00
AR(1)	- 0.30	0.03	- 9.83	0.00
AR(2)	- 0.21	0.03	- 6.41	0.00
AR(3)	- 0.13	0.03	- 4.01	0.00
AR(4)	- 0.08	0.03	- 2.52	0.01
AR(11)	- 0.07	0.03	- 2.48	0.01

R-squared	0.79	Mean dependent var	0.05
Adjusted R-squared	0.79	S.D. dependent var	0.36
S.E. of regression	0.17	Akaike info criterion	- 0.75
Sum squared resid	28.33	Schwarz criterion	- 0.72
Log likelihood	397.03	Durbin-Watson stat	2.00

Inverted AR Roots	.70+.23i	.70-.23i	.48-.63i	.48+.63i
	.10-.80i	.10+.80i	-.35-.72i	-.35+.72i
	-.68+.44i	-.68-.44i	- 0.80	

Dependent Variable: Fund nr. 19
Method: Least Squares
Date: 05/12/07 Time: 16:46
Sample (adjusted): 12 1050
Included observations: 1039 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CREDIT_B_INDEX	0.22	0.01	15.46	0.00
CREDIT_BB_INDEX	0.35	0.02	14.16	0.00
CREDIT_INV_GRADE	0.40	0.02	16.39	0.00
AR(1)	- 0.21	0.03	- 6.73	0.00
AR(2)	- 0.13	0.03	- 4.09	0.00
AR(3)	- 0.09	0.03	- 2.75	0.01
AR(11)	- 0.06	0.03	- 2.14	0.03

R-squared	0.78	Mean dependent var	0.05
Adjusted R-squared	0.77	S.D. dependent var	0.36
S.E. of regression	0.17	Akaike info criterion	- 0.68
Sum squared resid	30.48	Schwarz criterion	- 0.64
Log likelihood	359.06	Durbin-Watson stat	2.00

Inverted AR Roots	.71+.23i	.71-.23i	.48-.61i	.48+.61i
	.10-.79i	.10+.79i	-.33-.71i	-.33+.71i
	-.67+.42i	-.67-.42i	- 0.80	

Dependent Variable: Fund nr. 19
Method: Least Squares
Date: 05/12/07 Time: 16:41
Sample (adjusted): 12 1050
Included observations: 1039 after adjustments
Convergence achieved after 15 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AFRICA	0.08	0.02	3.30	0.00
EUROPE	0.34	0.02	16.41	0.00
LATIN	0.54	0.02	32.43	0.00
AR(1)	- 0.30	0.03	- 9.59	0.00
AR(2)	- 0.21	0.03	- 6.62	0.00
AR(3)	- 0.14	0.03	- 4.39	0.00
AR(4)	- 0.09	0.03	- 2.82	0.00
AR(11)	- 0.07	0.03	- 2.39	0.02

R-squared	0.80	Mean dependent var	0.05
Adjusted R-squared	0.80	S.D. dependent var	0.36
S.E. of regression	0.16	Akaike info criterion	- 0.79
Sum squared resid	27.29	Schwarz criterion	- 0.75
Log likelihood	416.49	Durbin-Watson stat	2.00

Inverted AR Roots	.69+.23i	.69-.23i	.48-.63i	.48+.63i
	.11-.79i	.11+.79i	-.35-.72i	-.35+.72i
	-.68+.44i	-.68-.44i	- 0.79	

Dependent Variable: Fund nr. 19
Method: Least Squares
Date: 05/12/07 Time: 16:53
Sample (adjusted): 4 1050
Included observations: 1047 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_10_TO_LONG	0.44	0.03	16.68	0.00
_07_TO_10	0.19	0.04	4.89	0.00
_03_TO_05	0.19	0.06	3.36	0.00
_01_TO_03	0.20	0.07	2.81	0.01
AR(1)	- 0.24	0.03	- 7.69	0.00
AR(2)	- 0.15	0.03	- 4.61	0.00
AR(3)	- 0.09	0.03	- 2.79	0.01

R-squared	0.77	Mean dependent var	0.05
Adjusted R-squared	0.77	S.D. dependent var	0.36
S.E. of regression	0.17	Akaike info criterion	- 0.67
Sum squared resid	30.86	Schwarz criterion	- 0.64
Log likelihood	359.25	Durbin-Watson stat	2.01

Inverted AR Roots	.08-.45i	.08+.45i	- 0.40

A3.6. Index 4

Dependent Variable: Index 4
Method: Least Squares
Date: 05/17/07 Time: 12:48
Sample (adjusted): 14 726
Included observations: 713 after adjustments
Convergence achieved after 4 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
H0A1_INDEX	0.38	0.00	257.19	-
H0A2_INDEX	0.46	0.00	231.54	-
H0A3_INDEX	0.16	0.00	176.99	-
AR(1)	0.14	0.04	3.79	0.00
AR(13)	0.10	0.04	2.68	0.01
AR(5)	0.09	0.04	2.30	0.02

R-squared	0.9995	Mean dependent var	0.00
Adjusted R-squared	0.9995	S.D. dependent var	0.00
S.E. of regression	0.0000	Akaike info criterion	- 17.38
Sum squared resid	0.0000	Schwarz criterion	- 17.34
Log likelihood	6,202	Durbin-Watson stat	2.00

Inverted AR Roots	0.86	.74+.37i	.74-.37i	.48+.70i
	.48-.70i	.12+.83i	.12-.83i	-.29+.77i
	-.29-.77i	-.63-.56i	-.63+.56i	-.79-.21i
	-.79+.21i			

A3.7. Fund 10

Dependent Variable: Fund nr. 10
Method: Least Squares
Date: 05/17/07 Time: 12:55
Sample (adjusted): 5 726
Included observations: 722 after adjustments
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
H0A3_INDEX	0.12	0.02	5.77	0.00
H0A2_INDEX	0.69	0.04	15.46	0.00
H0A1_INDEX	0.15	0.03	4.39	0.00
AR(1)	- 0.08	0.04	- 2.24	0.03
AR(4)	0.09	0.04	2.57	0.01

R-squared	0.77	Mean dependent var	0.00
Adjusted R-squared	0.76	S.D. dependent var	0.00
S.E. of regression	0.00	Akaike info criterion	- 11.08
Sum squared resid	0.00	Schwarz criterion	- 11.05
Log likelihood	4,005	Durbin-Watson stat	2.01

Inverted AR Roots	0.53	-.02+.55i	-.02-.55i	- 0.57