

**Tilburg University**

## **Style Analysis and Performance Evaluation of Dutch Mutual Funds**

Ter Horst, J.R.; Nijman, T.E.; de Roon, F.A.

*Publication date:*  
1998

[Link to publication in Tilburg University Research Portal](#)

*Citation for published version (APA):*

Ter Horst, J. R., Nijman, T. E., & de Roon, F. A. (1998). *Style Analysis and Performance Evaluation of Dutch Mutual Funds*. (CentER Discussion Paper; Vol. 1998-50). *Econometrics*.

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Style Analysis and Performance Evaluation of Dutch Mutual Funds

Jenke R. ter Horst<sup>1</sup>, Theo E. Nijman<sup>2</sup> and Frans A. de Roon<sup>3</sup>

May 8, 1998

<sup>1</sup>Department of Econometrics, Tilburg University, PO Box 90153, 5000 LE Tilburg, The Netherlands. E-mail: J.R.terHorst@KUB.NL. Financial support by the Netherlands Organization for Scientific Research (N.W.O) is gratefully acknowledged.

<sup>2</sup>CentER for Economic Research and Department of Econometrics, Tilburg University.

<sup>3</sup>Department of Finance, Erasmus University Rotterdam.

## **Abstract**

In this paper we show how style analysis of mutual funds can be used to circumvent the problem of self-reported investment styles, and to improve relative performance evaluation. Subsequently, we relate style analysis to performance evaluation and present results on the performance of Dutch mutual funds. Most strikingly, Dutch mutual funds that mainly invest in Netherlands equity show relative outperformance of the passive portfolio of indices reflecting the mutual fund's investment style. Moreover, the same group of funds provide an extension of the mean-variance efficient investment set for Dutch investors, even after taking short sales restrictions into account, indicating that a domestic market effect might be present.

# 1 Introduction

Differences in exposure to investment styles can explain a large part of the cross-sectional variation in mutual fund returns. Nevertheless, many investors and the financial press often simply compare realized mutual fund returns without taking differences in exposures into account. In so-called relative performance evaluation, mutual fund returns are compared with each other or with a benchmark asset covering the fund's investment style. Mutual fund managers that are aware of this fact can improve the outcome of relative performance evaluation by investing in securities that are not in accordance with their stated investment style or objective (see, Brown and Goetzmann [1997]).

In order to avoid gaming of benchmark assets, return-based style analysis, introduced by Sharpe [1992], can be used as an objective instrument to determine the mutual fund's investment style. After having determined the effective investment mix of a portfolio, performance evaluation can be based simply on a comparison of the mutual fund's return with a similar passive portfolio of indices. Alternatively, it can be assumed that a mutual fund is exposed to one investment style only that can be estimated from the data (see, Brown and Goetzmann [1997]).

In this paper we focus on the performance of Dutch mutual funds over the period January 1990 through June 1997. We take equity as well as fixed income funds into account, and we will evaluate the performances of these funds on a relative as well as on a risk-adjusted basis. We will consider the question whether a Dutch investor can extend his mean-variance efficient set by investing in Dutch mutual funds with respect to a set of passive indices. Moreover, we show under which assumptions relative performance evaluation and performance evaluation on a risk-adjusted basis lead to similar conclusions about the potential ability of the fund managers.

The remainder of this paper is organized as follows. In Section 2 we motivate the use of style analysis in mutual fund performance evaluation. Section 3 analyzes the investment styles and the relative performance of the sample of Dutch mutual funds. Moreover, we present some descriptive statistics for the sample of Dutch mutual funds that we employ. Section 4 evaluates fund performances on a risk-adjusted basis and answers the question whether mean-variance investors can improve the risk-return tradeoff by taking a position in a Dutch mutual fund. In Section 5 we take short sales constraints into account, and we analyze the impact of these constraints on mutual fund

performance evaluation. Finally, Section 6 concludes.

## 2 Return-based Style Analysis

Portfolio managers are often restricted to hold assets in a well-defined number of asset classes and are frequently limited to little or no leverage. One of the key determinants of a mutual funds' return is the asset allocation of the manager. For instance, for a mutual fund that primarily invests in equity this can mean that the management has to decide about the sectorial and regional allocation of the stocks and on the part to invest in growth stocks and the part to invest in value stocks.

As stressed by Brown and Goetzmann [1997], the self-reported investment style of the mutual fund does not always correspond to the actual investment behaviour. Consequently, in relative performance evaluation some mutual fund returns are compared with benchmark asset returns that do not correspond to the fund's actual investment style, possibly leading to a better relative mutual fund performance. As shown by, for instance, Sirri and Tufano [1997], individual investors select funds on prior performance information, investing more in funds that performed well over the last period. It is hard to judge whether fund managers are gaming relative performance evaluation on purpose or that there are other reasons for the observed misclassification. However, the impact on performance evaluation is the same.

Return-based style analysis (see, e.g. Sharpe [1992]), is an instrument to determine the exposure of a mutual fund to a number of major asset classes. To accomplish this task the following asset class model can be used

$$r_{t+1} = a + \sum_{k=1}^K b_k R_{kt+1} + u_{t+1}, \quad (1)$$

where  $r_{t+1}$  denotes the return on a mutual fund,  $K$  is the number of asset class factors,  $b_k$  is the sensitivity of  $r_{t+1}$  to the factor-mimicking portfolio  $R_{kt+1}$  and  $u_{t+1}$  is the idiosyncratic fund return, independent of all factor-mimicking returns. One of the main characteristics of asset class models is that the sensitivities are required to sum to 1, and should be larger than or equal to zero. The first characteristic implies that  $\sum_{k=1}^K b_k R_{kt+1}$  can be interpreted as the return on a passive portfolio with the same investment style as the mutual fund. The second characteristic reflects the short selling restrictions often present for mutual fund managers. The constant  $a$  can be

interpreted as the average tracking error between the mutual fund and the passive portfolio.

The primary goal of style analysis is not to evaluate a mutual fund's performance but to find a mimicking strategy that corresponds to the investment style of the mutual fund as closely as possible. After having determined this strategy, the mutual fund return in the subsequent periods can be compared with this passive strategy. In that way, a part of the fund's return can be assigned to investment style and a part can be assigned to active selection of the management. Therefore, style analysis can be used to circumvent the problem of self-reported styles in relative performance evaluation, and moreover, can be accomplished using return data only.

One of the aims of performance evaluation is to detect whether the fund manager has certain abilities that makes the fund an attractive investment product, such that an investor can extend his efficient investment set by taking a position in the mutual funds under consideration. Suppose that the return of a mutual fund can be written as

$$r_{t+1} = w'R_{t+1} + \alpha_{t+1}, \quad (2)$$

where  $\alpha_{t+1} \sim N(\alpha, \Sigma_\alpha)$  reflects the ability of the fund manager,  $R_{t+1}$  is a  $K$ -dimensional vector of returns of asset classes and  $w$  is the corresponding weight vector.

Reconsider the following regression equation:

$$r_{t+1} = a + BR_{t+1} + u_{t+1}, \quad (3)$$

where  $B$  is a row vector of exposure coefficients to the  $K$  initial assets or asset classes and  $u_{t+1}$  is the idiosyncratic error term that is uncorrelated with all  $K$  asset class returns. The constant  $a$  is the parameter of interest and serves the purpose of measuring the potential ability of the fund manager. If we assume that the ability of the fund manager,  $\alpha_{t+1}$ , is independent of the return on the  $K$  asset classes  $R_{t+1}$  then it is straightforward to show that  $B$  in (3) can be written as

$$B = \frac{Cov[w'R_{t+1} + \alpha_{t+1}, R_{t+1}]}{Var[R_{t+1}]} = w' \quad (4)$$

implying that  $B$  reflects the weights in the asset classes. Moreover, under the same assumption,

$$a = E[r_{t+1}] - BE[R_{t+1}] = E[\alpha_{t+1}] = \alpha \quad (5)$$

Table 1: **Number of Funds per Investment Category and Size in guilders.** The table reports the number of mutual funds in existence before year  $t$  per investment category, and the the amount to manage, as reported in December 1996.

year investment region	1990	1993	1997/06	Size (in billion guilders)
European Equity	5	9	10	2.9
Regional/Country	9	13	33	11.8
North American Equity	7	9	11	1.0
Netherlands Equity	6	10	43	8.7
International Equity	14	18	31	22.5
European Bonds	4	9	18	2.8
Netherlands mix/balanced	5	9	11	2.4
Netherlands Guilder Bonds	8	21	45	12.5
International mix/balanced	10	13	15	5.2
International Bonds	13	17	24	23.2
total	81	128	241	93

and that is the ability we are interested in. Consequently, under the assumption that the ability of the fund manager is independent of the return on the asset classes, return-based style analysis is an appropriate way to identify the potential ability of the fund manager.

### 3 Relative Performance Evaluation

The database that we employ contains 289 Dutch mutual funds, equity as well as fixed income and other types of funds, and is provided by Micropal Inc. Following previous studies on performance evaluation, we concentrate primarily on equity and fixed income funds. The sample that we analyze starts in January 1990. In Table 1 we present the main investment regions for the sample of funds as well as the number of funds with self-reported investment style corresponding to these investment regions. It appears that since the end of the eighties the number of funds has grown enormously. During the last four years e.g., the number of funds has almost doubled. The funds that primarily invest in the Netherlands is the largest group, i.e. 99 out of the total number of 241. At the end of 1996, the total amount to manage is 47 billion guilders for equity funds and 46 billion guilders for fixed income funds. The largest equity fund is Robeco (International Equity) and

**Table 2: Summary Statistics.** Panel A of the table presents the average monthly return as well as the minimum and maximum return per investment category. Panel B reports the average monthly returns and the corresponding standard deviations (between parenthesis) for the asset classes.

Panel A: average monthly returns per investment category						
period investment region	1990-1997/6			1993-1997/6		
	mean	min	max	mean	min	max
European Equity	0.76	0.20	1.10	1.77	1.40	2.78
Regional/Country	0.48	-0.15	1.36	1.17	0.44	1.58
North American Equity	1.24	0.69	2.10	1.58	0.98	2.72
Netherlands Equity	1.46	1.15	1.68	1.94	0.69	2.46
International Equity	0.90	-0.11	1.40	1.56	0.48	2.28
European Bonds	0.79	0.61	1.15	0.73	0.33	1.68
Netherlands mix/balanced	1.00	0.84	1.12	1.25	0.43	1.57
Netherlands Guilder Bonds	0.52	0.25	0.75	0.51	0.18	0.79
International mix/balanced	0.64	0.33	1.04	0.97	0.56	1.43
International Bonds	0.61	0.40	0.79	0.62	0.27	1.38
Panel B: average monthly returns and standard deviations asset classes						
MSCI europe (Seurope)	1.09	(4.23)		1.73	(3.55)	
MSCI world (Sworld)	0.89	(4.57)		1.58	(3.91)	
Sal. Brothers G7 bond (Bworld)	0.80	(3.29)		0.84	(3.18)	
CBS stock index (Sneth)	1.59	(3.91)		2.41	(3.78)	
CBS bond index (Bneth)	0.74	(0.98)		0.71	(1.04)	
3-month deposit (depos)	0.52	(0.20)		0.38	(0.12)	

the largest fixed income fund is Rorento (International Bonds) with 10.5 and 7.4 billion guilders respectively under management at the end of 1996.

In Panel A of Table 2 we present the average monthly return per investment category for the sample of mutual funds. During the period 1990-1997/06 as well as the subperiod 1993-1997/07, the funds that primarily invest in Dutch equity have the highest average monthly return, i.e. 1.46% and 1.94% respectively (approximately 17.5% and 23.3% annually).

In relative performance evaluation, the average return of a mutual fund is compared with a benchmark that corresponds to the investment style. Panel B of Table 2 reports the average monthly returns and the corresponding standard deviations for the following six asset classes over two sample periods: three equity style indices: MSCI World equities, MSCI Europe equities, CBS Netherlands equities, two bond style indices: Salomon Brothers G7 bond in-



dex, the CBS general bond index and a three-month Dutch currency deposit. Looking at the results in Table 2 it appears that on average, for instance, Dutch mutual funds with main investment objective 'Netherlands Equity' underperform the corresponding Dutch stock index by 0.13% over the period 1990-1997/06, while over the subperiod 1993-1997/06 this underperformance increases to 0.47%. However, the average fund with investment objective 'International Equity' does hardly show under or outperformance of the MSCI World index.

An explanation for the underperformance of the mutual funds might be that the mutual funds hold a cash position as well. One of the reasons for having such a liquidity position is that mutual funds can quickly respond to investors which sell their share in the mutual fund, without having to sell a corresponding part of the mutual fund's portfolio immediately. Therefore, a direct comparison between the return on the fund and the return on the index corresponding to the self-reported style is somewhat unfair. Style analysis will be used to circumvent this problem. Moreover, as mentioned by Brown and Goetzmann [1997], fund managers can easily mislead relative performance evaluation by investing in assets classes or parts of the world that are not in accordance with their reported investment style.

In order to examine whether the reported investment style coincides with the actual style, we apply return-based style analysis using the six style indices introduced above. Note that these indices can be interpreted as factor-mimicking portfolios for the factors that drive asset returns. In Table 3 we present a weighted average exposure for the main investment categories that is obtained by estimating the constrained regression equation (1) for the sample of Dutch equity funds. The weight of a fund in the computation of the weighted average is determined by the size of the fund as reported at the end of 1996.

Not surprisingly, on average, the estimated maximum exposure within an investment category corresponds to the investment objective as reported by the mutual fund. However, if we look at funds with investment objective 'International Equity' then it appears that these funds are highly exposed to Dutch equity. Consequently, relative performance evaluation could in fact be gamed by the fund managers, since most of the mutual funds are overweighting Dutch equity. Furthermore, an individual investor that is considering to extend his portfolio with an internationally investing mutual fund, actually invests in a fund that is highly exposed to the domestic market. Moreover, if we compare the exposure of funds with investment objective 'Netherlands eq-

**Table 3: Estimated Exposures.** The table shows the weighted-average estimated style of Dutch equity funds (in the columns labelled 'avg(wgt)') for five self-reported investment categories over the periods 1990-1997/06 and 1993-1997/06. The weight of the fund is determined by the size of the fund at the end of 1996. The columns labelled 'max' report the maximum estimated exposure of a fund in this investment category to a style index, while the column 'nr' reports the number of funds in the investment category that are exposed to a style index. The estimate for  $a$  is in % per month, while the number of funds behind the estimate for  $a$  is the total number of funds in the investment category.

Investment Region	European equity			Regional equity			North American equity		
period 1990 - 1997/06									
	avg(wgt)	max	nr	avg(wgt)	max	nr	avg(wgt)	max	nr
$a$	-0.23	-0.06	5	0.03	0.17	9	0.40	1.19	7
Seurope	0.59	0.76	4	0.26	0.41	3	0.04	0.22	2
Sworld	0.02	0.03	2	0.51	1.00	9	0.32	0.59	5
Bworld	0.00	0.09	1	0.08	0.18	2	0.46	0.78	6
Sneth	0.27	0.57	5	0.13	0.42	3	0.14	0.18	4
Bneth	0.07	0.43	3	0.00	0.00	0	0.00	0.00	0
depos	0.05	0.23	5	0.02	0.17	3	0.05	0.94	2
$R^2$	0.69	0.82		0.54	0.63		0.43	0.68	
period 1993 - 1997/06									
$a$	0.05	1.17	9	-0.45	-0.06	13	0.10	2.35	9
Seurope	0.66	0.85	9	0.17	0.88	4	0.09	0.30	5
Sworld	0.09	0.84	7	0.77	1.00	10	0.20	0.91	7
Bworld	0.00	0.09	2	0.00	0.30	1	0.34	0.58	8
Sneth	0.15	0.32	5	0.06	0.31	3	0.30	0.44	7
Bneth	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0
depos	0.10	0.54	8	0.00	0.13	4	0.08	1.00	5
$R^2$	0.75	0.94		0.39	0.63		0.58	0.77	

Table 3 continued

Investment Region	Netherlands equity			International equity		
period 1990 - 1997/06						
	avg(wgt)	max	nr	avg(wgt)	max	nr
<i>a</i>	0.22	0.29	6	-0.09	0.18	14
Seurope	0.12	0.17	6	0.09	0.36	13
Sworld	0.00	0.01	1	0.51	0.71	12
Bworld	0.00	0.03	1	0.01	0.40	6
Sneth	0.76	0.92	6	0.30	0.59	13
Bneth	0.03	0.08	2	0.01	0.23	5
depos	0.08	0.25	5	0.08	0.75	9
$R^2$	0.85	0.89		0.86	0.90	
period 1993 - 1997/06						
<i>a</i>	0.46	0.97	10	-0.10	0.56	18
Seurope	0.23	0.39	8	0.16	1.00	16
Sworld	0.05	0.13	7	0.53	0.76	16
Bworld	0.00	0.03	1	0.01	0.21	4
Sneth	0.50	0.74	10	0.22	0.50	14
Bneth	0.02	0.20	1	0.00	0.11	1
depos	0.20	0.73	9	0.09	0.73	15
$R^2$	0.72	0.92		0.82	0.88	

uity' over the two sample periods, then it appears that during the subperiod 1993-1997/06 mutual funds are more exposed to the cash deposit, indicating that mutual funds held more cash during this period. Consequently, the average monthly underperformance of 0.47% (Table 2) might be due to this rather large position in cash. The relatively low value of  $R^2$  for the funds with objective 'Regional equity' and 'North American equity' indicates that the style indices that we employ do not sufficiently cover the actual investment style for these mutual funds.

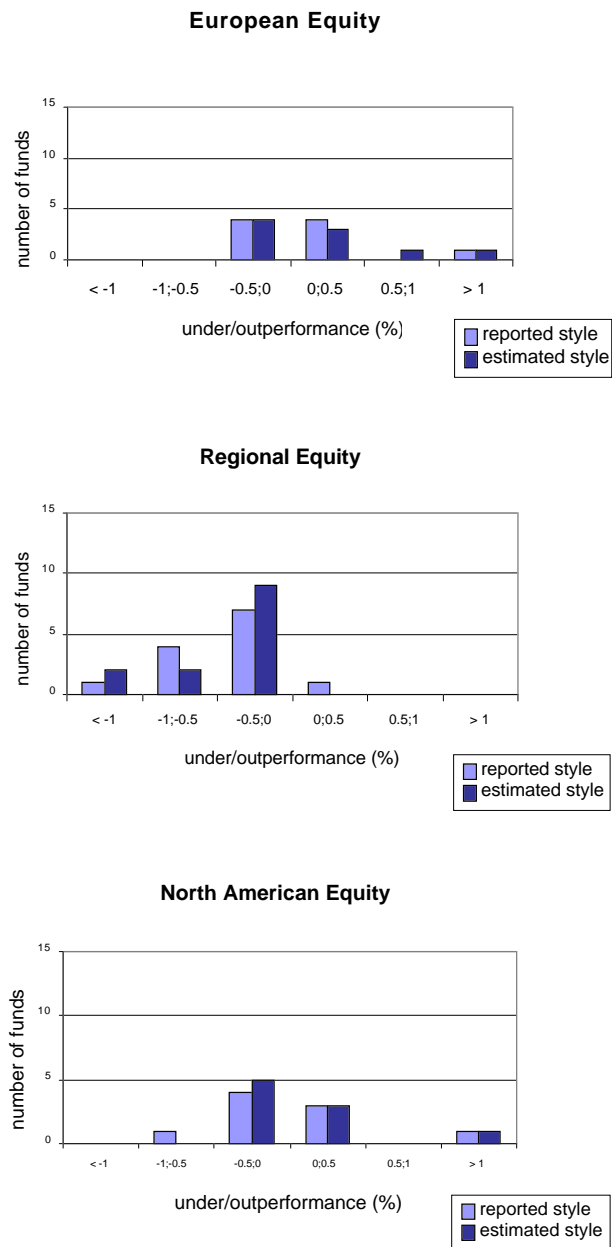
In order to illustrate the effect of using style analysis in relative performance evaluation, we show in Figure 1 histograms for the relative performance of mutual funds over the period 1993 through 1997/06. In Figure 1, we compare relative performance evaluation using a benchmark that corresponds to the reported investment style with relative performance evaluation using the fund's estimated exposure to a passive portfolio of indices as bench-

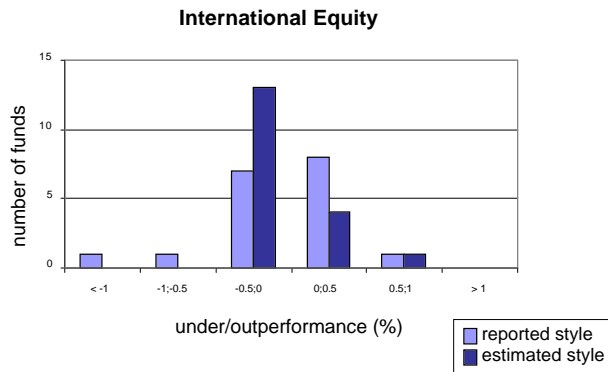
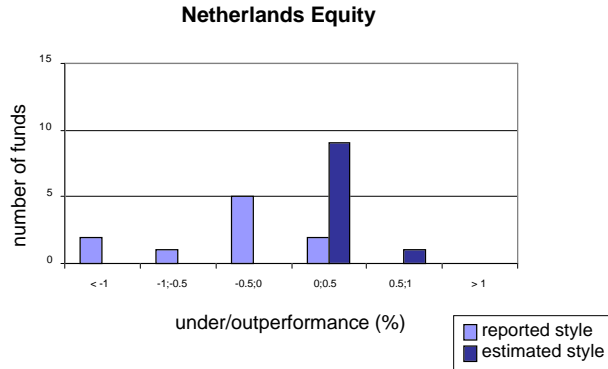
mark. Note that our analysis differs from Brown and Goetzmann [1997], who assume that all funds invest in one investment style only, that is estimated from the data. In general, it appears to be the case that the relative performance of mutual funds improves when using the estimated style of a fund as a benchmark. In particular, all the mutual funds with investment objective 'Netherlands equity' outperform the estimated style, while most of them underperform the Dutch CBS stock index, indicating that the cash position that the mutual funds hold seriously affects relative performance evaluation. As an illustration, at the individual fund level, one of the largest funds at the end of 1996 with objective 'Netherlands equity', i.e. the ABN AMRO Netherlands fund, outperformed the Dutch CBS stock index with only 0.04% per month, while after taking the exposure to different asset classes into account, the outperformance increases to almost 0.40% per month. The fund has an average estimated exposure to cash of almost 8% over the period 1993-1997/06.

For funds with investment objective 'International equity' the result is somewhat different. Although the extreme underperformance of a number of funds that was present in case of performance evaluation relative to the reported style has disappeared, most of the funds slightly underperform the replicating strategy that covers the fund's investment style, while the largest part of this group outperformed the benchmark corresponding to the reported investment style, i.e. thirteen vs nine funds respectively. For these funds some gaming might be present, probably caused by the exposure to Dutch equity.

For Dutch fixed income mutual funds we repeated the above style analysis. The result can be found in appendix A. Similar to the equity funds, it appears that most fixed income mutual funds have an estimated style that corresponds to the self-reported investment style. However, the funds with objective 'International bonds' are heavily exposed to the Dutch CBS bond index. Consequently, a Dutch investor that considers to extend his initial portfolio with an internationally investing fixed income fund, is actually looking at funds that are highly exposed to the Dutch fixed income market.

Figure 1: **Relative Performance (%per month)**. The figures show the relative under or outperformance of the sample of mutual funds compared to the reported style or to the fund's estimated exposure to a passive portfolio of indices as benchmark. The evaluation period is 1993 - 1997/06.





## 4 Performance Evaluation using the Jensen Measure

One of the best known traditional ways of measuring mutual fund performances is the Jensen measure (Jensen [1968]). The generalized Jensen measure can be obtained as the intercept in the following regression equation:

$$(r_{t+1} - \eta) = \alpha_J(\eta) + B(R_{t+1} - \eta \iota_K) + v_{t+1}, \quad (6)$$

where  $r_{t+1}$  is the return vector of the mutual fund,  $R_{t+1}$  is a  $K$ -dimensional return vector of some benchmark assets,  $\iota_K$  is a  $K$ -dimensional vector of ones,  $\eta$  is the risk free rate (if available) or some prespecified zero beta rate<sup>1</sup>

---

<sup>1</sup>The zero beta rate  $\eta$  is the return on a portfolio that is uncorrelated with the investor's initial portfolio, and is therefore related to the investor's risk aversion.

associated with the investor's portfolio with expected return  $\mu$ ,  $B$  is a  $1 \times K$  row vector of slope coefficients and  $v_{t+1}$  is the idiosyncratic error term which is uncorrelated with the  $K$  benchmark assets and has expectation zero. Note that  $\alpha_J(\eta)$  generalizes the original alpha-measure proposed by Jensen [1968]. First of all, Jensen assumed that one of the benchmark assets is a risk free deposit, what implies that the zero beta rate equals the risk free rate. Secondly, Jensen considered the case of only two benchmark assets, i.e. the risk free rate and the market portfolio, while  $K$  in (6) is not restricted to two.

In a test for outperformance of a mutual fund with respect to  $K$  benchmark assets, the following hypothesis is tested:

$$H_0 : \alpha_J(\eta) = 0. \tag{7}$$

Alternatively, testing of the hypothesis (7) can be interpreted as testing whether an investor with a particular risk aversion cannot extend the mean-variance efficient set by investing in the mutual fund, where  $\eta$  is the zero beta rate of the investor's portfolio corresponding to the investor's risk aversion. Or put differently, testing of (7) can be interpreted as testing for intersection of the initial and extended mean-variance frontier in the investor's initial optimal portfolio location. As shown by, for instance Elton, Gruber and Blake [1996], a positive Jensen measure indicates that a mean-variance investor whose current portfolio is covered by the  $K$  benchmark assets can extend the mean-variance efficient set by taking a long position in the fund under consideration. A negative measure implies an extension by taking a short position in the fund.

It is important to note that there is a close link between the generalized Jensen measure and performance evaluation relative to the investment style estimated from return-based style analysis as in Section 3. It is straightforward to show that the generalized Jensen measure can be written as

$$\alpha_J(\eta) = a - (1 - B\iota_K)\eta, \tag{8}$$

where  $a$  and  $B$  can be obtained from the Huberman and Kandel [1987] regression equation (3). Recall that in return-based style analysis, equation (3) is estimated under the assumption that  $B\iota_K = 1$ . This implies that in return-based style analysis we already impose a part of the null hypothesis (7). Moreover, the restriction that the individual exposure coefficients should be equal or greater than zero is assumed to hold in the population.

Let us consider the case that where (2) holds, i.e. the fund manager's ability is uncorrelated with all style indices. In that case the generalized Jensen measure reduces to the parameter  $a$  which serves the purpose of measuring the ability of the fund manager as shown in (5). Consequently, the generalized Jensen measure has the advantage that it is directly related to efficient portfolio choice, but reduces to relative performance evaluation in an important special case. Note that in evaluating performances using the generalized Jensen measure it is usually not assumed that the ability of the fund manager is uncorrelated with the return on the  $K$  benchmark assets, and in that sense, the generalized Jensen measure is less restrictive in detecting a manager's ability.

In Table 4 we report the weighted-average generalized Jensen measure for the five investment categories, where we assume that the investor's initial portfolio is an efficient combination of the six asset class indices of Section 3. The weight of a fund in the computation of the weighted-average is, as before, determined by the size of the fund as reported at the end of 1996. We do not impose that an investor is obligated to invest all his wealth, implying the availability of a risk free asset with zero return<sup>2</sup>. For the sample period 1990-1997/06, we consider two different expected returns on the investor's portfolio. First of all, we consider an expected return of 0.55% monthly on his current efficient portfolio of  $K$  benchmark assets, which corresponds with a zero beta rate of 0.00%. This portfolio is the zero tangency portfolio, i.e. for expected returns greater than or equal to 0.55% all wealth is invested in the risky assets. Second, we consider an expected return of 3.5% on the investor's portfolio, corresponding to a zero beta rate of 0.534%. This zero beta rate corresponds to the intercept of the asymptote of the mean-variance frontier of the benchmark assets. Alternatively, it can be stated that this zero beta rate reflects the behavior of a risk neutral investor. We also computed the generalized Jensen measure for the subperiod 1993-1997/06. For this case, the zero tangency portfolio has an expected return of 0.40%, while an expected return of 3.5% on the investor's efficient portfolio now corresponds to a zero beta rate of 0.38%.

From the estimates based on the period 1990-1997/06 it appears that, on average, the mutual funds with investment objective 'Netherlands equity' offer the investor an extension of the efficient set by taking a long position in most of the mutual funds under consideration, independent of the investor's

---

<sup>2</sup>It is not allowed to take a short position in a risk free asset with zero return.



**Table 4: Generalized Jensen measure.** The table reports for two sample periods and a number of different expected returns on the investor's portfolio a weighted-average generalized Jensen measure with corresponding standard deviation (in the columns labelled 'avg(wgt)') as well as the minimum and maximum generalized Jensen measure per investment category. The weight of the fund in the weighted-average is determined by the size of the fund at the end of 1996. The standard deviation of the weighted-average is calculated by taking the correlations between the individual funds into account. All the values are on a monthly basis. A Jensen measure printed in *italics indicates significant at the 5% level.*

Investment Region	$\mu = 0.55\%$				$\mu = 3.50\%$			
	avg(wgt)	min	max		avg(wgt)	min	max	
	$\alpha_J$	$\alpha_J$	$\alpha_J$		$\alpha_J$	$\alpha_J$	$\alpha_J$	
period 1990 - 1997/06								
Europe	0.40 (0.64)	-0.14	0.65		-0.28 (0.22)	-1.51	-0.06	
Regional	<i>-2.67</i> (1.14)	<i>-3.75</i>	0.20		-0.16 (0.40)	<i>-1.27</i>	0.13	
North America	0.39 (0.81)	-1.14	<i>9.57</i>		0.40 (0.28)	-0.23	1.46	
Netherlands	0.58 (0.41)	-0.27	<i>1.23</i>		0.21 (0.14)	-0.15	0.29	
International	-0.16 (0.39)	-0.91	1.11		-0.08 (0.14)	-0.91	0.18	
period 1993 - 1997/06								
	$\mu = 0.40\%$				$\mu = 3.50\%$			
Europe	0.43 (0.56)	-4.10	<i>1.73</i>		0.07 (0.19)	<i>-0.28</i>	0.90	
Regional	<i>-4.60</i> (2.25)	<i>-5.81</i>	-1.39		-0.54 (0.75)	<i>-1.53</i>	0.13	
North America	<i>2.53</i> (0.81)	0.56	<i>12.66</i>		0.14 (0.27)	-0.38	<i>3.60</i>	
Netherlands	<i>1.05</i> (0.51)	-0.24	2.98		<i>0.49</i> (0.17)	0.10	<i>1.06</i>	
International	0.45 (0.59)	-7.88	<i>1.60</i>		-0.11 (0.20)	-0.45	0.52	

risk aversion. These mutual funds show outperformance of the set of  $K$  benchmark assets, while the funds with investment objective 'Regional' or 'International equity' mostly underperform the  $K$  benchmark assets. For the estimates based on the subperiod 1993-1997/06 a comparable pattern is found. Independent of the investor's risk aversion, most of the mutual funds with investment objective 'Netherlands' offer the investor an extension of the efficient set by taking a long position in the funds under consideration.

The observed outperformance on a relative as well as on a risk-adjusted basis of Dutch mutual funds that mainly invest in the Netherlands might be an indication of a domestic market effect. The knowledge of the stock market where the fund is located might explain why this particular group of fund managers appears to have ability. Note that underperformance corresponds with taking a short position in the mutual funds for an extension of the efficient set. However, an investor will be confronted with short sales restrictions. Moreover, it is straightforward to show that a positive generalized Jensen measure for a mutual fund can coincide with short positions in the benchmark assets, which is an important drawback of this measure of outperformance.

At the individual fund level the result of the EDCC Netherlands Antilles fund (North American equity) is most striking. For the zero tangency portfolio the fund shows a significant extreme outperformance of about 9.5% and 12.5% on a monthly basis, for the period 1990-1997/06 and the subperiod 1993-1997/06 respectively. The outperformance of this fund also explains the average outperformance of the group of funds with investment objective 'North American equity'. When we take into account the estimated exposure to the different investment style indices that we obtained in Section 3 for this fund, it appears that the fund is highly exposed to the three-month currency deposit. Since the currency deposit is included in the set of  $K$  benchmark assets, the extreme outperformance cannot be explained by the huge exposure to this three-month currency deposit. Apparently, it is the case that the EDCC Netherlands Antilles fund is not a traditional mutual fund that is limited to little or no leverage (see also Fung and Hsieh [1997]). Consequently, the risk involved for a position in a so-called hedge fund is on average much higher than for a traditional fund. For the EDCC Netherlands Antilles fund the risk, as measured by the standard deviation, appears to be almost 10%, which is twice the risk involved in a position in the other funds within the same investment style.

## 5 Performance Analysis under Short Sales Restrictions

Since it is usually not possible for an individual investor to take a short position in a mutual fund or a benchmark asset, it is relevant to consider tests for outperformance of mutual funds under short sales constraints on the mutual funds as well as on the benchmark assets, with the exception of the three-month currency deposit. Markowitz [1991] has shown that the mean-variance frontier of all benchmark assets and the mutual fund under consideration consists of  $P$  segments where different assets have binding short sales restrictions. As shown by DeRoos, Nijman and Werker [1997], a test whether the efficient set can be extended by also investing in the mutual fund for an investor with zero beta rate  $\eta$  and short sales constraints, can be implemented by estimating the following regression equation

$$(r_{t+1} - \eta) = \alpha_j^{(p)}(\eta) + B^{(p)}(R_{t+1}^{(p)} - \eta \iota_L^{(p)}) + v_{t+1}^{(p)}, \quad (9)$$

where the superscript  $(p)$  means that the regression is based on the subvector  $R_{t+1}^{(p)}$  of  $R_{t+1}$  that corresponds to the assets that are actually in the investor's portfolio, i.e. for which the short sales constraints are not binding. A test for extension of the efficient set is equivalent to testing whether the following hypothesis:

$$\alpha_j^{(p)}(\eta) \leq 0, \quad (10)$$

holds. This one-sided inequality constraint (10) can be tested using the Wald test under inequality constraints (see, e.g. Kodde and Palm [1986]).

Similar to the unrestricted case, we test the hypothesis for a number of expected returns on the investor's efficient portfolio. For the sample period 1990 - 1997/06 the investor's initial efficient portfolio under short sales restrictions consists of three assets, i.e. CBS stock index, CBS bond index and a three-month deposit, independent of the investor's risk aversion. For the sample period 1993-1997/06, the initial portfolio of assets also consists of the Morgan Stanley Europe index for risk aversions corresponding to a zero beta rate of 0.00%. In Table 5 we report the weighted-average generalized Jensen measure under short sales restrictions for five investment categories for different expected returns. For the sample period 1990-1997/06 we test for outperformance for an expected return of 0.54% associated with the zero tangency portfolio, and for an expected return of 3.5%. Recall that the zero

Table 5: **Generalized Jensen measure under short sales constraints.** The table reports for two sample periods and a number of different expected returns on the investor's portfolio a weighted-average generalized Jensen measure and corresponding standard deviation (in the columns labelled 'avg(wgt)') under short sales constraints as well as the minimum and maximum generalized Jensen measure per investment category. The weight of the fund in the weighted-average is determined by the size of the fund at the end of 1996. The standard deviation of the weighted-average is calculated by taking the correlations between the individual funds into account. All the values are on a monthly basis. A Jensen measure printed in *italics* indicates significant at the 5% level.

Investment Region	$\mu = 0.54\%$			$\mu = 3.50\%$		
	avg(wgt)	min	max	avg(wgt)	min	max
	$\alpha_J$	$\alpha_J$	$\alpha_J$	$\alpha_J$	$\alpha_J$	$\alpha_J$
period 1990 - 1997/06						
Europe	0.09 (0.72)	-0.71	0.78	-0.53 (0.25)	-1.10	-0.35
Regional	-3.40 (1.29)	-4.40	-0.25	-0.67 (0.44)	-2.02	-0.44
North America	-0.37 (1.05)	-2.23	<i>9.31</i>	0.02 (0.36)	-0.79	0.73
Netherlands	0.52 (0.41)	-0.23	<i>1.12</i>	0.16 (0.14)	-0.14	0.21
International	-0.63 (0.63)	-1.26	1.27	-0.47 (0.22)	-0.15	-0.12
period 1993 - 1997/06						
	$\mu = 0.40\%$			$\mu = 3.50\%$		
Europe	0.37 (0.56)	-4.63	<i>1.67</i>	-0.25 (0.28)	-0.65	0.67
Regional	-5.56 (2.78)	-6.50	-1.30	-1.28 (0.98)	-2.04	-0.42
North America	<i>2.41</i> (0.99)	0.59	<i>12.41</i>	-0.28 (0.33)	-0.97	<i>3.10</i>
Netherlands	<i>1.01</i> (0.50)	-0.31	<i>2.95</i>	<i>0.37</i> (0.18)	0.00	<i>0.90</i>
International	0.13 (0.79)	-7.70	<i>1.37</i>	-0.44 (0.29)	-0.77	0.26

beta rate for this portfolio with a rather high expected return can be obtained as the intercept of the asymptote of the mean-variance frontier of the CBS stock index, CBS bond index and a three-month deposit.

If it is not possible for an individual investor to take a short position in a mutual fund, the negative numbers in the table indicate that the investor cannot extend the efficient set by taking a position in these funds. It appears that the mutual funds that primarily invest in 'Netherlands equity' show outperformance of the benchmark assets, even after imposing short sales restrictions. Usually, it is found that only a small number of funds have a positive Jensen measure in a frictionless market (see, e.g. Malkiel [1995], Gruber [1996]). Although the outperformance is only significant for one out

of ten mutual funds in a market with short sales constraints, the fact that for most of these funds the generalized Jensen measures is positive, is remarkable and might be due to a domestic market effect.

In order to illustrate the effect of imposing short sales restrictions on the benchmark assets in more detail, we show in the Figures 2 until 6 the generalized Jensen measure without (unrestricted) as well as with imposing short sales restrictions (restricted). In both cases, we consider an expected return of 1.5% per month on the investor's current efficient portfolio of benchmark assets. Note that in the unrestricted case the investor's initial portfolio consists of  $K$  benchmark assets, while in the restricted case the initial portfolio only consist of the CBS stock index, CBS bond index and a three-month currency deposit. Moreover, in the unrestricted case an expected return of 1.5% corresponds to a zero beta rate of 0.379%, while in the case of short sales constraints the zero beta rate equals 0.384%.

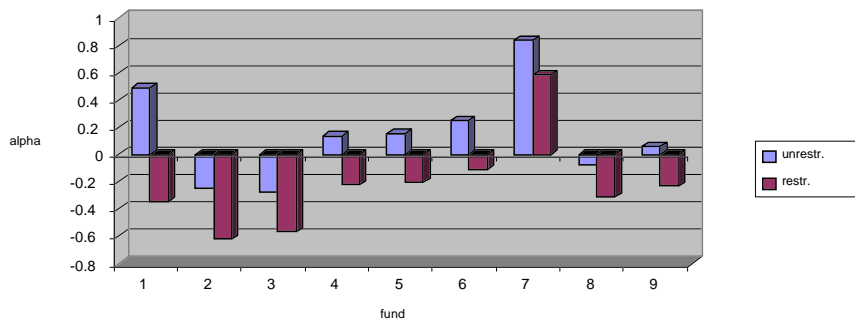


Figure 2: The generalized Jensen measures for European Equity Funds.

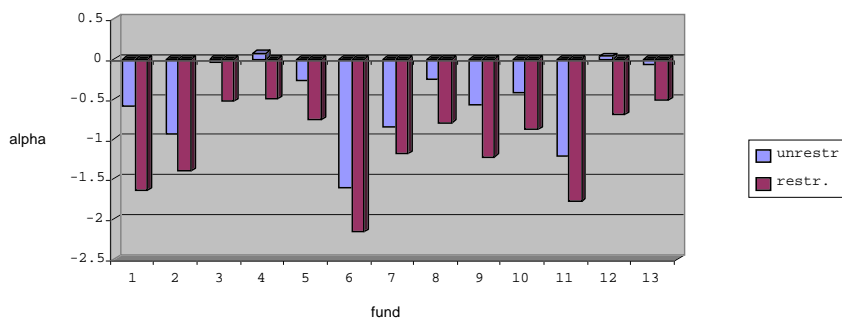


Figure 3: The generalized Jensen measures for Regional Equity funds.

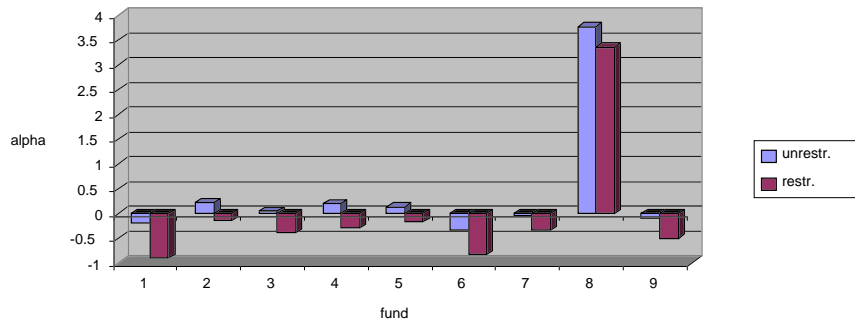


Figure 4: The generalized Jensen measure for North American Equity funds.

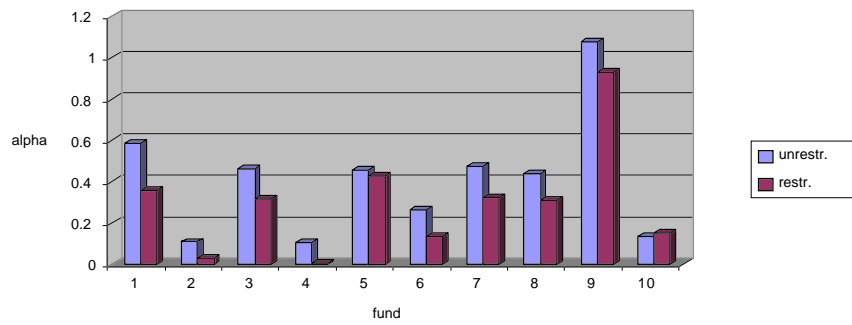


Figure 5: The generalized Jensen measures for Netherlands Equity funds.

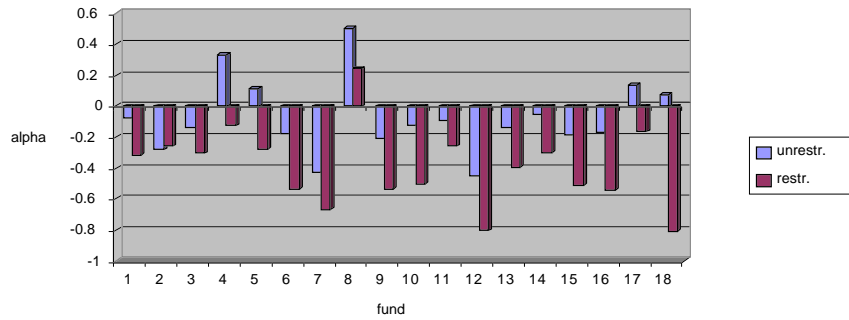


Figure 6: The generalized Jensen measure for International Equity funds.

A striking result from Figures 2 to 6 is that the average performance of all fund categories decreases when short sales constraints on the benchmark are taken into account. This must be due to the fact that in the unrestricted

case the investor could have extended the efficient set by short selling a number of the benchmark assets. Apparently it is the case that the short sales restrictions together with the correlation of the mutual funds with the remaining benchmark assets leads to a decrease in the generalized Jensen measure.

## 6 Concluding Remarks

Returns-based style analysis is useful for improving relative performance evaluation of mutual funds. Since the actual investment style of a mutual fund does not necessarily correspond with the self-reported investment style, simply comparing realized fund returns with benchmarks corresponding to the reported styles might be misleading. In this paper we have shown that style analysis can be used to objectively determine a fund's actual investment style. For most of the funds in the sample of Dutch mutual funds that we employ in this paper, it appears that the maximum estimated exposure to an investment style index corresponds with the self-reported style. However, a large number of the funds are also highly exposed to other style indices, such as a three-month currency deposit, indicating that the funds hold a large cash position as well. In a few cases, we find that the fund is more exposed to cash than to the self-reported style. In these cases the mutual fund is probably not a real mutual fund that is restricted to little or no leverage.

In order to answer the question whether Dutch investors can extend the efficient set by taking a position in a Dutch mutual fund, we evaluated the performances of the fund on a relative basis as well as by using the generalized Jensen measure. If we take into account the exposure to style indices, the relative performance increases for most of the mutual funds. In particular, the funds that mainly invest in 'Netherlands equity' outperform the passive portfolio reflecting the fund's investment style, while underperformance dominates using the self-reported style as benchmark. It appears that most of the funds in the sample show underperformance, however, the group of funds with investment objective 'Netherlands equity' mainly shows outperformance. This finding is robust for incorporating short sales restrictions on most of the benchmark assets, and for the risk attitude of the investor. Consequently, most mean-variance investors can extend the efficient set by taking a long position in Dutch mutual funds that mainly invest in 'Netherlands equity'.

A final point to note is that relative performance evaluation is more restrictive in detecting potential ability of a fund manager than risk-adjusted performance evaluation. Under the assumption that the manager's ability is independent of the return on the benchmark assets, relative performance evaluation is an appropriate method to evaluate mutual funds. Moreover, if the exposure to different asset classes is not known, style analysis can be used as the instrument to determine these exposures.

## **A Style Analysis: Fixed Income Funds**



**Table 6: Estimated Exposure Fixed Income Funds.** The table reports the weighted-average estimated style of Dutch fixed income funds (in the columns labelled 'avg(wgt)') for five self-reported categories over the periods 1990-1997/06 and 1993-1997/06. The weight of the fund in the weighted-average is determined by the size of the fund at the end of 1996. The columns labelled 'max' report the maximum estimated exposure of a fund to a style index, while the column 'nr' reports the number of funds that are exposed to a style index. The estimate for  $\alpha$  is in % per month, while the number of funds behind the estimate for  $\alpha$  is the total number of funds in the investment category.

Investment Region	European bonds			Netherlands mix			Netherlands bonds		
period 1990 - 1997/06									
	avg(wgt)	max	nr	avg(wgt)	max	nr	avg(wgt)	max	nr
<i>a</i>	-0.05	-0.03	4	0.02	0.07	5	-0.12	0.02	8
Seurope	0.02	0.10	2	0.01	0.03	2	0.00	0.02	1
Sworld	0.03	0.38	3	0.01	0.03	2	0.01	0.04	3
Bworld	0.05	0.12	4	0.08	0.28	5	0.02	0.08	4
Sneth	0.03	0.41	2	0.38	0.41	5	0.01	0.09	4
Bneth	0.84	0.94	4	0.32	0.40	5	0.80	0.95	8
depos	0.03	0.49	3	0.20	0.26	5	0.16	0.54	8
R <sup>2</sup>	0.66	0.92		0.77	0.93		0.73	0.86	
period 1993 - 1997/06									
<i>a</i>	-0.17	0.05	9	0.12	0.44	9	-0.13	0.09	21
Seurope	0.06	0.11	6	0.08	0.35	7	0.00	0.12	2
Sworld	0.02	0.44	4	0.08	0.15	5	0.00	0.01	1
Bworld	0.07	0.14	6	0.07	0.15	8	0.02	0.18	17
Sneth	0.02	0.44	4	0.30	0.38	9	0.02	0.06	13
Bneth	0.53	0.91	9	0.15	0.41	7	0.70	0.95	20
depos	0.30	0.51	7	0.33	0.57	9	0.25	1.00	19
R <sup>2</sup>	0.59	0.92		0.70	0.93		0.75	0.86	

Table 6 continued

Investment Region	International mix			International bonds		
period 1990 - 1997/06						
	avg(wgt)	max	nr	avg(wgt)	max	nr
<i>a</i>	-0.18	0.02	10	-0.10	0.01	13
Seurope	0.03	0.19	9	0.01	0.11	5
Sworld	0.18	0.39	10	0.06	0.12	7
Bworld	0.02	0.10	7	0.10	0.89	13
Sneth	0.14	0.33	9	0.01	0.08	9
Bneth	0.32	0.42	10	0.67	0.86	11
depos	0.32	0.70	10	0.15	0.65	11
R <sup>2</sup>	0.70	0.91		0.64	0.82	
period 1993 - 1997/06						
<i>a</i>	-0.14	0.14	13	-0.20	-0.05	17
Seurope	0.09	0.35	11	0.03	0.20	12
Sworld	0.09	0.44	13	0.04	0.97	6
Bworld	0.05	0.13	10	0.12	0.83	17
Sneth	0.17	0.25	11	0.01	0.15	10
Bneth	0.33	0.49	10	0.52	0.88	13
depos	0.27	0.65	12	0.27	0.72	13
R <sup>2</sup>	0.80	0.90		0.63	0.83	

## References

- Brown, S.J. and W.N. Goetzmann, 1997, Mutual Fund Styles, *Journal of Financial Economics*, 43, 373-399.
- DeRoos F.A., Th. E. Nijman and B.J.M. Werker, 1998, Testing for Mean-Variance Spanning with Short Sales Constraints and Transaction Costs: The Case of Emerging Markets, *Center Dp no. 9807*, Tilburg University.
- Elton, E., M.J. Gruber and C.R. Blake, 1996, The Persistence of Risk-Adjusted Mutual Fund Performance, *Journal of Business*, 69, 133-157.
- Fung, W. and D.A. Hsieh, 1997, Empirical Characteristics of Dynamic Trading Strategies: The Case Of Hedge Funds, *Review of Financial Studies*, 10, 275-302.

- Gruber, M.J., 1996, Another Puzzle: The Growth in Actively Managed Mutual Funds, *Journal of Finance*, 51, 783-811.
- Huberman, G. and S. Kandel, 1987, Mean-Variance Spanning, *Journal of Finance*, 42, 873-888.
- Jensen, M.C., 1968, The Performance of Mutual Funds in the period 1945-1964, *Journal of Finance*, 23, 389-416.
- Kodde, D.A. and F.C. Palm, 1986, Wald Criteria for Jointly Testing Equality and Inequality Restrictions, *Econometrica*, 54, 1243-1248.
- Malkiel, B.G., 1995, Returns from Investing in Equity Mutual Funds 1971 to 1991, *Journal of Finance*, 50, 549-572.
- Markowitz, H.M., 1991, Portfolio Selection, Basil Blackwell, Cambridge, Massachusetts.
- Sharpe, W.F., 1992, Asset Allocation: Management Style and Performance Measurement, *Journal of Portfolio Management*, Winter, 7-19.
- Shukla, R.K. and G.B. van Inwegen, 1995, Do Locals Perform Better than Foreigners?: An Analysis of UK and US Mutual Fund Managers, *Journal of Economics and Business*, 47, 241-254.
- Sirri, E.R. and P. Tufano, 1997, Costly Search and Mutual Fund Flows, forthcoming *Journal of Finance*.