On Intraday Time-Reversibility of Return Processes

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Abstract

It is a well-known fact that daily return processes are not time-reversible. This means that the distribution of daily returns ($r_{\text{day},1}$, ..., $r_{\text{day},N}$) over N days does not equal that of the time-reversed daily returns $(r_{\text{day},N}, \ldots, r_{\text{day},1})$. We introduce the dual notion of intraday time-reversibility, essentially meaning that high-frequency returns ($A_{1,n}$, ..., $A_{I,n}$) of frequency $\Delta = 1/I$ can be time-reversed into ($A_{I,n}$, ..., $A_{1,n}$) on any day n, without changing the distribution of the whole return process. We proceed by showing that quite a lot of processes belong to this class, including Lévy processes as well as processes with interday GARCH-like behaviour, as e.g. the so-called BIG-GARCH model, recently proposed by Venter, de Jongh and Griebenow. Next we prove that intraday time-reversibility implies bivariate interchangeability of some intraday ratios, these ratios being built using only open, close, high and low prices. Applying conditional inference permutation tests on bivariate interchangeability developed by Ernst and Hollander, we reject the hypothesis of intraday time-reversibility of return processes for two thirds of the components of the DJIA, almost 90 % of the S&P 500 shares and all stocks of the German DAX, thereby showing that most return processes are neither Lévy nor BIG-GARCH processes.

JEL-classifications: C52, G10
Keywords: Intraday Price Process, Time-Reversibility, Lévy Process, BIG-GARCH Process, High-Low-Prices, Permutation Test

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1 Introduction

Although in 1990, Tong conjectured that "time irreversibility is the rule rather than the exception when it comes to non-linearity" ([Ton90], p. 197), time-reversibility of economic variables has attracted a lot of attention over the last decade:

- in 1994, Rothman found that weekly stock returns exhibit time irreversibility ([Rot94]),
- in 1996, Ramsey and Rothman investigated macroenomic time series and introduced the notion of time-reversibility to the context of business cycles ([RaRo96]),
- in 1998, Hinich and Rothman proposed a frequency domain test of time reversibility ([HiRo98]),
- in 2000, Chen, Chou and Kuan developed a methodology to test for time-reversibility without moment restrictions, which allowed them to show that stock index returns are not time-reversible ([ChChKu00]),
- in 2003, Chen and Kuan used the above-mentioned time-reversibility test to investigate stock index returns as well as residuals from certain ARCH- and GARCH models to fit the index returns series ([ChKu03]),
- also in 2003, Fong found evidence for time-reversible volatility of daily stock returns in contrast to time-irreversible trading volume ([Fon03]),
- only recently, McCausland analyzed time-reversibility of regular finite-state Markov chains ([McC07]).

In the empirical application, the development has turned from investigating macroeconomic time series of low frequency, e.g. annual data, to more and more disaggregated time series of higher, up to daily, frequency. The present paper aims at advancing this process to high-frequent data, i.e. intraday data. It is organized as follows:

First we introduce the notion of intraday time-reversibility, the appropriate analogue to time-reversibility, which in the following will be called interday time-reversibility to distinguish the two notions. Intraday time-reversibility essentially means that high-frequency returns on any day are time-reversible: for an intraday time-reversible process there is no change in distribution when the high-frequency returns' order is reversed.

In section 2, we provide a formal definition for intraday time-reversibility and show that the class of intraday time-reversible processes contains at least all Lévy processes and some processes with GARCH-type behaviour of daily returns, thereby proving that return processes can well be interday time-irreversible, yet intraday time-reversible. This raises the question whether empirical return processes possibly are intraday time-reversible.

In order to develop a test for intraday time-reversibility we proceed by investigating the properties of two ratios built by using only daily high, low, open and close prices: the maximal and minimal returns' average, scaled by the range, and the difference of the daily return and this average, again scaled by the range. For intraday time-reversible processes, it turns out that these ratios are not only identically distributed, but even bivariately interchangeable, which makes it possible to test for intraday time-reversibility by using tests on bivariate interchangeability.

Section 3 is devoted to choosing appropriate test procedures for testing bivariate interchangeability: for this purpose, permutation tests of Ernst and Hollander are used. They have the advantage of being exact tests, even when returns on different days are not independent.

In section 4, these tests are used to empirically investigate index and stock returns, including German DAX, Dow Jones Industrial Average and S&P 500, as well as their components. After finding strong evidence for intraday time-irreversibility, section 5 concludes.

2 Intraday Time-Reversible Processes

2.1 Notations and basic definitions

We denote by

$$P_{t,n}\,(t \in [0,1]) \tag{1}$$

the price of some security on trading day n, where, for ease of notation, we assume the trading interval (on every day n) to be $[0,1]$, i.e. we measure time in terms of a fraction of the trading day, such that $t=0$ corresponds to opening and $t=1$ to closing time. We further denote by

$$r_{t,n} := \log(P_{t,n}/P_{0,n}) \tag{2}$$

the (cumulative) return up to time t on day n, which is achieved on day n by buying on opening time ($t=0$) and selling at time t. The return process $r_{t,n}$ should not be mixed up with high-frequency returns

$$A_{i,n} := \log(P_{i\Delta,n}/P_{(i-1)\Delta,n}) = r_{i\Delta,n} - r_{(i-1)\Delta,n} \tag{3}$$

of frequency $\Delta = 1/I$, $i = 1, \dots, I$.
Using these notations we define the maximal, minimal and daily returns on day n by

$$r_{\max,n} := \sup_{t\in[0,1]} r_{t,n},\; r_{\min,n} := \inf_{t\in[0,1]} r_{t,n},\; r_{\mathrm{day},n} := r_{1,n}. \tag{4}$$

By definition, we have $r_{\min,n} \leqslant 0 \leqslant r_{\max,n}$. Notice that, in order to calculate $r_{\max,n}$, $r_{\min,n}$ and $r_{\mathrm{day},n}$, it suffices to know open, close, high and low prices on day n, as

$$r_{\max,n} = \log \sup_{t\in[0,1]} P_{t,n} - \log P_{0,n}, \tag{5}$$

$$r_{\min,n} = \log \inf_{t\in[0,1]} P_{t,n} - \log P_{0,n}, \tag{6}$$

$$r_{\mathrm{day},n} = \log P_{1,n} - \log P_{0,n}. \tag{7}$$

Recall the well-known notion of (interday) time-reversibility: the daily returns are said to be (interday) time-reversible if the distribution of ($r_{\mathrm{day},1}$, …, $r_{\mathrm{day},N}$) equals that of the time-reversed daily returns ($r_{\mathrm{day},N}$, …, $r_{\mathrm{day},1}$). When looking for a dual notion of intraday time-reversibility, it is natural to think of the high-frequency returns ($A_{1,n}$, …, $A_{I,N}$) of frequency $\Delta = 1/I$ being time-reversible for each day n. Building on this essential idea, a few comments are in order: first of all, intraday time-reversibility should not depend on the frequency Δ, i.e. we want time-reversibility of high-frequency returns for all possible frequencies Δ. As $r_{i\Delta,n} = \sum_{j=1}^{i} A_{j,n}$, time-reversibility of high-frequency returns entails $r_{i\Delta,n}$ having the same distribution as

$$\sum_{j=1}^{i} A_{I+1-j,n} = r_{\text{day},n} - \sum_{j=1}^{I-i} A_{j,n} = r_{\text{day},n} - r_{1-i\Delta,n},$$

which shows that time-reversibility of all high-frequency returns is equivalent to

$$(r_{t,n})_{t\in[0,1]} \stackrel{d}{=} (r_{1,n} - r_{1-t,n})_{t\in[0,1]}. \tag{8}$$

In addition to (8) we have to take into account the possibility of reverting the time clock only on a selection of the days $1,\ldots,N$ as well as the fact that time running backwards on some day n should not change the distribution of returns on other days. That's why finally we arrive at the following definition of intraday time-reversibility:

Definition 2.1

We call the return process $r_{t,n}$ intraday time-reversible if for every $N \in \mathbb{N}$ and every sequence $(s_1,\ldots,s_N) \in \{0,1\}^N$

$$((r_{t,1})_{t\in[0,1]},\ldots,(r_{t,N})_{t\in[0,1]}) \stackrel{d}{=} ((\widetilde{r}_{t,1})_{t\in[0,1]},\ldots,(\widetilde{r}_{t,N})_{t\in[0,1]}), \tag{9}$$

with $\widetilde{r}_{t,n} := \begin{cases} r_{t,n} & , s_n = 1 \\ r_{1,n} - r_{1-t,n} & , s_n = 0 \end{cases}$ *for* $t \in [0,1]$, $n = 1,\ldots,N$.

As already stated, intraday time-reversibility means that time can run backwards on some days n, which are specified by vanishing s_n. On those days, returns aren't measured as usual, i.e. over the interval $[0,t]$ from opening to t, but backwards from closing to $1-t$ over the interval $[1-t,1]$, as $r_{1,n} - r_{1-t,n} = \log(P_{1,n}/P_{0,n}) - \log(P_{1-t,n}/P_{0,n}) = \log(P_{1,n}/P_{1-t,n})$.

An important property of intraday time-reversible processes is given by the following lemma, which especially shows that the maximal and minimal returns' average $(r_{\max,n} + r_{\min,n})/2$, scaled by the range $r_{\max,n} - r_{\min,n}$, has the same distribution as the difference of the daily return $r_{\text{day},n}$ and this average, again scaled by the range:

$$\frac{(r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}} \stackrel{d}{=} \frac{r_{\text{day},n} - (r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}}.$$

Lemma 2.2

If the return process $r_{t,n}$ is intraday time-reversible, then for every $n \in \mathbb{N}$ and every sequence $(s_1, \ldots, s_N) \in \{0,1\}^N$ we have

$$((\mathrm{R}_{1,1}, \mathrm{R}_{2,1}), \ldots, (\mathrm{R}_{1,N}, \mathrm{R}_{2,N})) \stackrel{d}{=} ((\widetilde{\mathrm{R}}_{1,1}, \widetilde{\mathrm{R}}_{2,1}), \ldots, (\widetilde{\mathrm{R}}_{1,N}, \widetilde{\mathrm{R}}_{2,N})), \tag{10}$$

$$\text{with } (\mathrm{R}_{1,n}, \mathrm{R}_{2,n}) := \left(\frac{(r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}}, \frac{r_{\mathrm{day},n} - (r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}} \right), \tag{11}$$

$$(\widetilde{\mathrm{R}}_{1,n}, \widetilde{\mathrm{R}}_{2,n}) := \begin{cases} (\widetilde{\mathrm{R}}_{1,n}, \widetilde{\mathrm{R}}_{2,n}) \ , \ s_n = 1 \\ (\widetilde{\mathrm{R}}_{2,n}, \widetilde{\mathrm{R}}_{1,n}) \ , \ s_n = 0 \end{cases} \tag{12}$$

for $t \in [0,1]$, $n = 1, \ldots, N$.

Proof: By (9) we can replace $r_{t,n}$ by $\widetilde{r}_{t,n} := r_{1,n} - r_{1-t,n}$ for all days n with $s_n = 0$ without changing the process' distribution. Some simple algebra shows that

$$\widetilde{r}_{\mathrm{day},n} = r_{\mathrm{day},n}, \ \widetilde{r}_{\max,n} = r_{\mathrm{day},n} - r_{\min,n} \text{ and } \widetilde{r}_{\min,n} = r_{\mathrm{day},n} - r_{\max,n}.$$

Using this, it follows

$$\frac{(\widetilde{r}_{\max,n} + \widetilde{r}_{\min,n})/2}{\widetilde{r}_{\max,n} - \widetilde{r}_{\min,n}} = \frac{r_{\mathrm{day},n} - (r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}}$$

$$\text{and } \frac{\widetilde{r}_{\mathrm{day},n} - (\widetilde{r}_{\max,n} + \widetilde{r}_{\min,n})/2}{\widetilde{r}_{\max,n} - \widetilde{r}_{\min,n}} = \frac{(r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}},$$

which completes the proof.

■

The preceding lemma not only states that for intraday time-reversible processes,

$$\mathrm{R}_1 := \frac{(r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}} \text{ and} \tag{13}$$

$$\mathrm{R}_2 := \frac{r_{\mathrm{day},n} - (r_{\max,n} + r_{\min,n})/2}{r_{\max,n} - r_{\min,n}} \tag{14}$$

have the same distribution, but that these two ratios fulfil bivariate interchangeability. It is an easy exercise to show that bivariate interchangeability of $(\mathrm{R}_1, \mathrm{R}_2)$ is in fact equivalent to

$$(D, S) \stackrel{d}{=} (-D, S) \text{ with } D := \mathrm{R}_1 - \mathrm{R}_2 \text{ and } S := \mathrm{R}_1 + \mathrm{R}_2 \,. \tag{15}$$

Using (15) it follows that bivariate interchangeability of $(\mathrm{R}_1, \mathrm{R}_2)$ is equivalent to R_1 and R_2 being identically distributed, conditional to $S := \mathrm{R}_1 + \mathrm{R}_2$. Notice that both R_1 and R_2 always lie between $-1/2$ and $1/2$, as can be easily seen by the relation

$$r_{\min,n} \leqslant r_{\mathrm{day},n} \leqslant r_{\max,n}.$$

This ensures especially that R_1 and R_2 have finite second order moments, which will be essential for the application of Ernst's E_N test for bivariate interchangeability of $(\mathrm{R}_1, \mathrm{R}_2)$.
We now proceed to show that Lévy processes are intraday time-reversible.

2.2 Lévy Processes are intraday time-reversible

At first glance, (9) seems to be very restrictive. Therefore the question arises, whether there are (considerably many) intraday time-reversible processes. Fortunately, it can be shown that all members of the quite large class of Lévy processes are intraday time-reversible. To see this, recall the definition of a Lévy process, which, loosely speaking, is a stochastic process with stationary independent increments (cf. [CoTa04]):

Definition 2.3

A stochastic process $(X_t)_{t \geqslant 0}$ *with* $X_0 = 0$ *is called a Lévy process if*

1. *for every increasing sequence of times* $t_0, \ldots, t_n$*, the random variables* X_{t_0}*,* $X_{t_1} - X_{t_0}$*, …,* $X_{t_n} - X_{t_{n-1}}$ *are independent (independent increments),*

2. *the law of* $X_{t+h} - X_t$ *does not depend on* t *(stationary increments),*

3. $\mathrm{P}\text{-}\lim\limits_{h \to 0} X_{t+h} = X_t$ *(stochastic continuity).*

Obviously, Brownian Motion is a special Lévy process: it has independent, stationary, normally distributed increments. The class of Lévy processes is quite large, and Lévy processes have been and still are intensively used in many branches of science. Recently, they have become increasingly popular in finance, since the previously predominating Brownian Motion cannot explain several so-called stylized facts which are typical for financial data. Especially with respect to option pricing, Lévy processes have been shown to outperform the Brownian Motion-based Black-Scholes model. There are — at least — four categories of Lévy process based models that have been introduced to the finance literature:

1. Carr, Madan and Chang put forward the VG (variance gamma) model ([MaCaCh98]);
2. the GH (generalized) hyperbolic Lévy processes was introduced by Eberlein and Keller ([EbKe95]);
3. Barndorff-Nielsen proposed the NIG (normal inverse Gaussian) model ([Bar98]);
4. and Carr, Geman, Madan and Yor came up with the CGMY process ([CaGeMaYo02]).

The following lemma, whose easy proof is omitted, shows that Lévy processes are time-reversible.

Lemma 2.4

For a Lévy process $(X_t)_{t\in[0,1]}$*, the process* $(\widetilde{X}_t := X_1 - X_{1-t})_{t\in[0,1]}$ *has the same distribution as* X*.*

When modelling asset returns, it is often assumed that return processes on different days are iid distributed. Combining independence and lemma 2.4 we arrive at the following lemma:

Lemma 2.5

If the return process $(r_{t,n})_{t\in[0,1]}$ *is assumed to be iid Lévy, then* $r_{t,n}$ *is intraday time-reversible.*

Of course there are models for returns that do not assume independence of returns on different days. Very prominent, when looking at daily data, are GARCH-type approaches. In the following we take a closer look at one of these, namely the so-called BIG-GARCH model of Venter, de Jongh and Griebenow.

2.3 The BIG-GARCH model by Venter et al.

A recent example for a model with GARCH-type daily returns ist the model by Venter, de Jongh and Griebenow ([VedJGr06]), who introduced a hybrid model between a traditional GARCH model and a stochastic volatility model, called Brownian inverse Gaussian Garch (BIG-GARCH) model. The basic assumption is that over each trading day anew intraday returns follow a Brownian motion with drift and volatility that in principle are inherited from the previous day in typical GARCH fashion, but are also adjusted by random, inverse Gaussian (IG) distributed factors, which model the impacts of news arriving between market closure on the previous day and the market's reopening. In the following we show that BIG-GARCH processes are intraday time-reversible.

In detail, the BIG-GARCH model makes the following assumptions (cf. [VedJGr06]): the return process $r_{t,n}$ follows, conditional on the information up to day $n-1$, a Brownian motion with drift $\mu_n + \beta\sqrt{h_n}W_n$ and volatility $h_n W_n$. It is further assumed that

$$\mu_n = \nu + \phi r_{\text{day},n-1}$$

evolves in an AR(1)-like fashion,

$$h_n = \alpha_0 + \alpha_1 (r_{\text{day},n-1} - \mu_{n-1})^2 + \beta_1 h_{n-1}$$

is a GARCH(1,1)-type equation and $\beta, \nu, \phi, \alpha_0, \alpha_1, \beta_1$ are parameters. W_n are independent unit inverse Gaussian $UIG(\psi)$-distributed[1] adjustment factors, which are also independent of the Brownian motions and who are to model the effect of information arriving between closing on day $n-1$ and opening on day n.

Notice that the daily returns $r_{\text{day},n}$ form an AR(1)-GARCH(1,1) process with standard normal inverse Gaussian $SNIG(\beta,\psi)$-distributed innovations (cf. [VedJGr06], [VedJGr05]): the conditional distribution of $r_{\text{day},n}$ can be written as

$$\mu_n + \sqrt{h_n}\left(\beta W_n + \sqrt{W_n} N(0,1)\right),$$

with $N(0,1)$ a standard normal variate and $X_n := \beta W_n + \sqrt{W_n} N(0,1)$ as $SNIG(\beta,\psi)$-distributed innovations of the AR(1)-GARCH(1,1) process. As GARCH processes are not time-reversible, daily returns of the BIG-GARCH process are not time-reversible. Nevertheless, it can be shown that BIG-GARCH processes are intraday time-reversible.

Lemma 2.6

Suppose the intraday return process $r_{t,n}$ to follow the BIG-GARCH model. Then $r_{t,n}$ is intraday time-reversible.

[1] The UIG-distribution is also known as Wald distribution.

Proof: Because Brownian motion is a special Lévy process, it is clear that replacing $(r_{t,n})_{t\in[0,1]}$ by $(\widetilde{r}_{t,n} := r_{1,n} - r_{1-t,n})_{t\in[0,1]}$ on day n doesn't change the distribution of the return process on that day. For the lemma to hold, we therefore must only show that this replacement does neither affect the next day's drift μ_{n+1} nor its volatility h_{n+1}. As

$$\widetilde{\mu}_{n+1} := \nu + \phi\widetilde{r}_{\text{day},n} = \nu + \phi r_{\text{day},n} = \mu_{n+1} \text{ and}$$

$$\widetilde{h}_{n+1} := \alpha_0 + \alpha_1(\widetilde{r}_{\text{day},n} - \mu_n)^2 + \beta_1 h_n = \alpha_0 + \alpha_1(r_{\text{day},n} - \mu_n)^2 + \beta_1 h_n = h_{n+1},$$

the proof is complete.

■

Inspection of the previous lemma's proof shows that it can be generalized in two ways:

1. The return process $(r_{t,n})_{t\in[0,1]}$ on day n does not need to be Brownian motion, but might be any Lévy process, or, even more generally, any process ensuring that $(\widetilde{r}_{t,n} := r_{1,n} - r_{1-t,n})_{t\in[0,1]}$ has the same distribution as $(r_{t,n})_{t\in[0,1]}$.
2. The inheritance of parameters (μ_n and h_n) does not need to be in AR(1)-GARCH(1,1) fashion. Any inheritance procedure invariant to changing $r_{t,n}$ into $\widetilde{r}_{t,n}$ could be allowed. For instance one could think of the new volatility parameter being (additionally) influenced by the returns' range $r_{\max,n} - r_{\min,n}$, which has the desired invariance property.

All in all, we can conclude that there are quite a lot of intraday time-reversible processes.

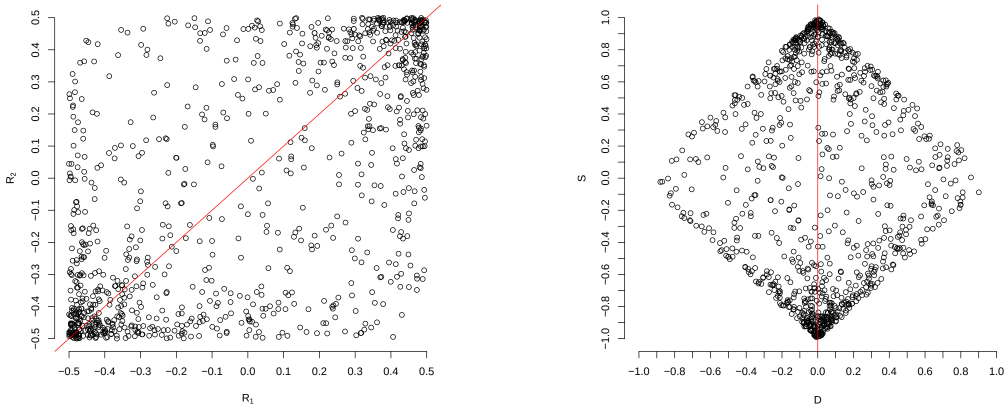

Figure 1: 1,000 Realisations of $(\mathrm{R}_1, \mathrm{R}_2)$ and (D, S) for Merton Jump-Diffusion

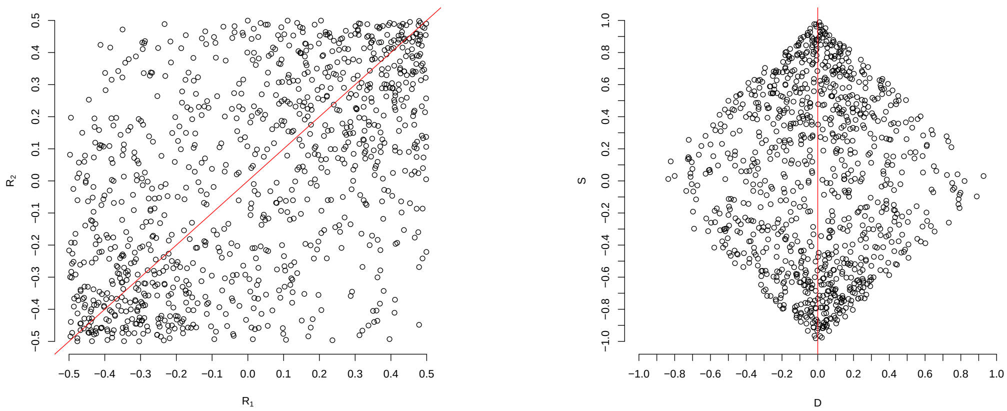

Figure 2: 1,000 Realisations of $(\mathrm{R}_1, \mathrm{R}_2)$ and (D, S) for BIG-GARCH process

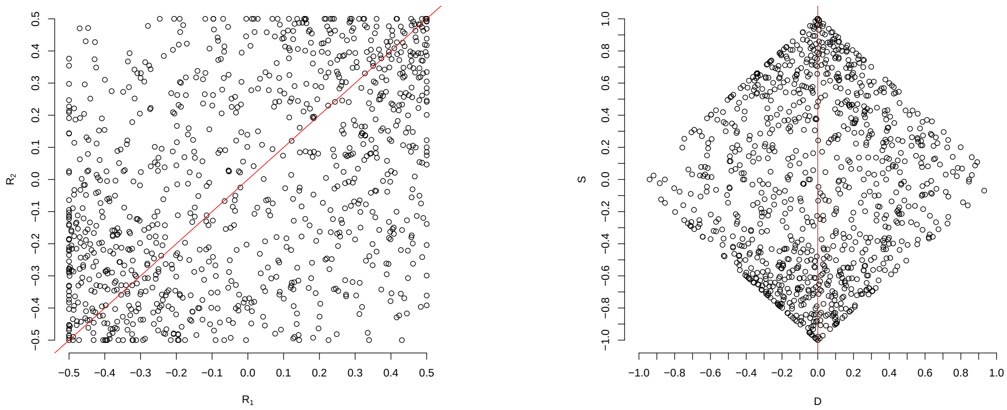

Figure 3: Scatterplots of $(\mathrm{R}_1, \mathrm{R}_2)$ and (D, S) for 1,000 days of IBM share

3 Testing on bivariate interchangeability when ties cannot be excluded

In the preceding section we showed bivariate interchangeability of

$$\mathrm{R}_1 = \frac{(r_{\max} + r_{\min})/2}{r_{\max} - r_{\min}} \text{ and } \mathrm{R}_2 = \frac{r_{\mathrm{day}} - (r_{\max} + r_{\min})/2}{r_{\max} - r_{\min}}$$

in case of intraday time-reversible returns. Therefore we can test for intraday time-reversibility of returns by testing bivariate interchangeability of $(\mathrm{R}_1, \mathrm{R}_2)$. Testing for bivariate interchangeability is a topic to which there have been several contributions in the literature[2] (see, e.g., [Ern97], [ErSc99], [Hol71], [KeRa84], [Sen67] and the references given in these papers). In order to select an appropriate test out of these, we stress the following: by inspecting figures 1 and 2, which show scatterplots of $(\mathrm{R}_1, \mathrm{R}_2)$ as well as $(D, S) = (\mathrm{R}_1, \mathrm{R}_2)$ for two different intraday time-reversible processes, it is easily seen that different return processes in general lead to different distributions of $(\mathrm{R}_1, \mathrm{R}_2)$, which merely share the property of bivariate interchangeability of $(\mathrm{R}_1, \mathrm{R}_2)$[3]. Therefore we have to use test procedures which are non-parametric as well as distribution-free.

Given these constraints we choose Ernst's E_N-test ([Ern97]) and Hollander's A-test ([Hol71], [HoWo99]). Concerning the latter we point out that Koziol's asymptotic approximation of the distribution of Hollander's test

[2]Often synonyms for 'bivariate interchangeability' are used, e.g.'bivariate symmetry'.

[3]Bivariate interchangeability corresponds to symmetry around the red lines.

statistic ([Koz79]) requires continuously distributed inputs as well as independence of $(\mathrm{R}_{1,n}, \mathrm{R}_{2,n})$ for different days n. As this is not guaranteed (in case of a BIG-GARCH process it is not fulfilled), we do not make use of it and instead compute the p-value for Hollander's test statistic, as well as that for Ernst's E_N, by permutation methods. These permutation methods have the advantage of not requiring independence of $(\mathrm{R}_{1,n}, \mathrm{R}_{2,n})$ for different days n. In the following we describe the two test procedures in some detail.

Ernst's E_N-test works as follows (for the following and more details see [Ern97], [ErSc99]):

- A sample $(\mathrm{R}_{1,1}, \mathrm{R}_{2,1}), \ldots, (\mathrm{R}_{1,N}, \mathrm{R}_{2,N})$ is transformed into

$$(D_1, S_1) = (\mathrm{R}_{1,1} - \mathrm{R}_{2,1}, \mathrm{R}_{1,1} - \mathrm{R}_{2,1}), \ldots$$
$$(D_N, S_N) = (\mathrm{R}_{1,N} - \mathrm{R}_{2,N}, \mathrm{R}_{1,N} - \mathrm{R}_{2,N}).$$

- Observe that Lemma 2.2 implies $(D, S) \stackrel{d}{=} (-D, S)$ for

$$(D, S) = (\mathrm{R}_1 - \mathrm{R}_2, \mathrm{R}_1 + \mathrm{R}_2),$$

  such that under the null hypothesis of intraday time-reversible returns we especially have $\mathrm{E}\, D = 0$ and $\mathrm{Cov}(D, S) = 0$, where the latter equation is equivalent to R_1 and R_2 having the same variance. Therefore, using the estimators

  - $\overline{D}$ for $\mathrm{E}\, D$,
  - $\widehat{\sigma}_D^2 := \overline{D^2}$ for $\mathrm{Var}\, D$,
  - $\widehat{\sigma}_S^2 := \frac{1}{N-1} \sum_{i=1}^{N} (S_i - \overline{S})^2$ for $\mathrm{Var}\, S$ and
  - $\widehat{\rho}_{DS} := \dfrac{\frac{1}{N-1} \sum_{i=1}^{N} (D_i - \overline{D})(S_i - \overline{S})}{\sqrt{\widehat{\sigma}_D^2 \widehat{\sigma}_S^2}}$ for $\mathrm{Corr}(D, S)$,

  the value

$$E_N := N \frac{\overline{D}^2}{\widehat{\sigma}_D^2} + (N-1)\widehat{\rho}_{DS}^2 \tag{16}$$

  should be 'small' under H_0.

- For every sequence $(s_1, \ldots, s_N)$ in $\{-1, 1\}^N$ the realisation $(s_1 D_1, S_1)$, …, $(s_N D_N, S_N)$ would under H_0 have been equally likely as the observed realisation $(D_1, S_1), \ldots, (D_N, S_N)$. In order to decide whether

E_N is 'large', which would lead to rejecting H_0, or whether E_N is 'small', which would amount to accepting H_0, one generates a large number of such sequences (each with probability $\frac{1}{2^N}$), calculates the corresponding values of E_N and computes the p-value as the relative frequency of those permutations which lead to E_N-values at least as large as the observed E_N.

- By rejecting H_0 if and only if the p-value is smaller than some given significance level α, one obtains a non-parametric distribution-free permutation test, which is an exact test for H_0.

Hollander's test works as follows (for the following and more details see [Hol71], [HoWo99]):

- Hollander's A-test statistic is defined as

$$A := N \int_{\mathbb{R}^2} (\widehat{F}_N(x,y) - \widehat{F}_N(y,x))^2 d\widehat{F}_N(x,y))(x,y), \tag{17}$$

where $\widehat{F}_N$ denotes the empirical cdf of $(\mathrm{R}_1, \mathrm{R}_2)$.

- The construction of A ensures that $\frac{A}{N}$ is an estimator for

$$\Delta := \int_{\mathbb{R}^2} (F(x,y) - F(y,x))^2 dF(x,y))(x,y), \tag{18}$$

where F denotes the cdf of $(\mathrm{R}_1, \mathrm{R}_2)$. As Δ equals 0 under H_0, 'large' values of A indicate a possible violation of H_0.

- In order to determine what is meant by 'large' values of the test statistic, we can apply the same procedure that is used in Ernst's E_N-test, i.e. we generate a large number of sign sequences $(s_1, \ldots, s_N)$ (each with probability $\frac{1}{2^N}$), calculate the values of A corresponding to the pseudo-realisations, and compute the p-value as the relative frequency of those permutations which lead to A-values at least as large as the observed A.

4 Empirical results

In our empirical investigation we tested $(\mathrm{R}_1, \mathrm{R}_2)$ on bivariate interchangeability by using Ernst's E_N- and Hollander's A-test as described in the preceding section. Given a sample of N quadruples of daily open, close, high and low prices, we first computed $r_{\mathrm{day},n}$, $r_{\mathrm{max},n}$, $r_{\mathrm{min},n}$ for every day $n = 1, \ldots, N$. We then computed

$$\mathrm{R}_{1,n} = \frac{(r_{\mathrm{max},n} + r_{\mathrm{min},n})/2}{r_{\mathrm{max},n} - r_{\mathrm{min},n}} \text{ and}$$

$$\mathrm{R}_{2,n} = \frac{r_{\mathrm{day},n} - (r_{\mathrm{max},n} + r_{\mathrm{min},n})/2}{r_{\mathrm{max},n} - r_{\mathrm{min},n}},$$

and used these as input for the permutation tests of Ernst and Hollander.

It is easily seen that Ernst's E_N-test uses only first and second moments of R_1 and R_2, whereas Hollander's A-test is based on the empirical cdf of $(\mathrm{R}_1, \mathrm{R}_2)$. So we might expect Hollander's test to have more power, because Ernst's E_N-test only checks for the first moments of R_1 and R_2 to coincide, whereas Hollander's test takes the whole empirical cdf into account.
We now present our empirical results[4]:

- First we investigated seven indices, including German DAX 30, Dow Jones Euro Stoxx, Dow Jones Industrials Average, Nasdaq 100, Nasdaq Composite, Nikkei 225 Stock Average and S&P 500 Composite. Table 1 (p. 15) shows that Ernst's test rejects intraday time-reversibility of returns for 4 of 7 indices, whereas Hollander's test rejects for all indices but the NASDAQ 100.

- Table 2 (p. 17) shows the results for the components of the Dow Jones Industrials Average. The null hypothesis of intraday time-reversible returns can be rejected for about one half of its components by Ernst's E_N-test and for about two thirds by Hollander's A-test.

- For the German DAX, results are given in Table 3 (p. 18). Here we find very strong evidence against intraday time-reversibility of returns, as the null hypothesis is rejected in 27 out of 29 cases by Ernst's test and in all cases by Hollander's test.

- We tested intraday time-reversibility for the IBM share over the period February 9, 1999 to January 31, 2003 (1000 days), which is exactly the period investigated by Venter et al. ([VedJGr06]). Here we find

[4] p-values based on 10,000 permutations, significant (5%) values in bold

$E_N = 2.316219$, $A = 0.382899$, $p_N = 0.8505$ and $p_H = 0.017$. Whereas Ernst's test cannot detect deviations from bivariate interchangeability, Hollander's A-test can do so. This might be due to the fact that E_N only considers the first two moments of R_1 and R_2, whereas the A-statistic makes use of the whole empirical cdf.[5]

- Finally we present in Table 4 (p. 22) the empirical results for 484 components of the S&P 500, for which we could retrieve data. From this table it can be seen that Ernst's test rejects intraday time-reversibility in 311 out of 484 cases, Hollander's test does so in 429 cases and it is a number of 435 shares for which the null hypothesis is rejected by at least one test.

All in all, we can state that our empirical results show in a very convincing manner that intraday return processes are not time-reversible, thereby generalising results already obtained in earlier works (cf. [BeFrKlSK07], [BeFrKlSK06], [Klö06]).

Name	E_N	p_{E_N}	A	p_A
DAX 30 PERFORMANCE (XETRA)	**26.1737**	0.0001	**1.1872**	0.0000
DJ EURO STOXX 50	27.8968	0.0519	**2.2566**	0.0000
DOW JONES INDUSTRIALS	5.4804	0.7100	**1.1885**	0.0000
NASDAQ 100	5.2360	0.2619	0.2293	0.0775
NASDAQ COMPOSITE	**11.4688**	0.0087	**0.4973**	0.0009
NIKKEI 225 STOCK AVERAGE	**8.3945**	0.0138	**0.5179**	0.0010
S&P 500 COMPOSITE	**14.7972**	0.0233	**1.3527**	0.0000

Table 1: Empirical results for 7 indices, $N = 1000$ days (up to 2006-11-10)

5 Summary

In this paper we have introduced the notion of intraday time-reversibility, which can be seen as the intraday equivalent to (interday) time-reversibility (of returns). We have shown that Lévy processes as well as certain GARCH-type processes, as for instance the BIG-GARCH process, belong to the class of intraday time-reversible processes. We further showed that intraday time-reversibility implies bivariate interchangeability of the maximal and minimal returns' average, scaled by the range, and the difference of the daily return

[5]Figure 3 (p. 11) shows scatterplots for these data.

and this average, again scaled by the range. This property was the key to empirical application, where we tested for bivariate interchangeability of these ratios by using permutation tests, such as Ernst's E_N- and Hollanders A-test. Rejection implies that returns are not intraday time-reversible, which further implies they are neither Lévy nor BIG-GARCH processes. The empirical results demonstrate convincingly that for most stock price processes the ratios R_1 and R_2 cannot be assumed to be bivariately interchangeable. This leads to the conclusion that most return processes are not only (interday) time-irreversible (a well-known fact), but also intraday time-irreversible.

Name	E_N	p_{E_N}	A	p_A
3M	6.2546	0.1111	0.2602	0.0597
ALCOA	**18.2157**	0.0111	**1.3829**	0.0000
ALTRIA GROUP INCO.	6.3841	0.4387	**0.4618**	0.0102
AMERICAN EXPRESS	8.0145	0.0761	0.2824	0.0527
AMERICAN INTL.GP.	**16.4334**	0.0033	**0.8960**	0.0000
AT&T	**17.8286**	0.0158	**1.1477**	0.0000
BOEING	5.7367	0.5258	0.2509	0.0564
CATERPILLAR	**7.7629**	0.0126	**0.4962**	0.0015
CITIGROUP	1.1129	0.6277	0.2403	0.0881
COCA COLA	**19.5825**	0.0143	**1.0109**	0.0001
DU PONT E I DE NEMOURS	8.0737	0.2283	**0.4032**	0.0135
EXXON MOBIL	0.3666	0.6239	0.1125	0.5307
GENERAL ELECTRIC	0.6880	0.4867	0.1700	0.2625
GENERAL MOTORS	**45.0122**	0.0000	**2.1722**	0.0000
HEWLETT-PACKARD	**24.5315**	0.0000	**0.6673**	0.0001
HOME DEPOT	9.4188	0.8984	**0.5555**	0.0033
HONEYWELL INTL.	**7.5303**	0.0201	**0.3546**	0.0261
INTEL	5.0703	0.0806	**0.2880**	0.0359
INTERNATIONAL BUS.MACH.	**51.6199**	0.0000	**1.3842**	0.0000
JOHNSON & JOHNSON	**17.2789**	0.0096	**0.5882**	0.0014
JP MORGAN CHASE & CO.	4.0569	0.5196	0.1663	0.2409
MCDONALDS	5.3553	0.9840	**0.3088**	0.0287
MERCK & CO.	19.1671	0.1132	**0.9762**	0.0000
MICROSOFT	**21.0222**	0.0000	**0.8336**	0.0002
PFIZER	14.4266	0.4500	**0.9207**	0.0002
PROCTER & GAMBLE	5.0703	0.2361	0.2533	0.0919
UNITED TECHNOLOGIES	**9.3310**	0.0199	**0.6615**	0.0004
VERIZON COMMS.	**16.5334**	0.0005	**1.0356**	0.0000
WAL MART STORES	**10.2553**	0.0076	**0.3325**	0.0332
WALT DISNEY	6.3383	0.5449	**0.3008**	0.0314

Table 2: Empirical results for DJIA components, $N = 1000$ days (up to 2006-11-10)

Name	E_N	p_{E_N}	A	p_A
ADIDAS (XET)	**16.9857**	0.0074	**1.0005**	0.0000
ALLIANZ (XET)	**51.8990**	0.0000	**2.2303**	0.0000
ALTANA (XET)	**31.1716**	0.0035	**1.5369**	0.0000
BASF (XET)	**25.4402**	0.0000	**1.1906**	0.0000
BAYER (XET)	**47.3330**	0.0000	**2.2980**	0.0000
BMW (XET)	46.0353	0.1107	**1.9708**	0.0000
COMMERZBANK (XET)	**29.2500**	0.0003	**1.7753**	0.0000
CONTINENTAL (XET)	**54.5212**	0.0000	**2.4620**	0.0000
DAIMLERCHRYSLER (XET)	**38.5822**	0.0000	**2.1884**	0.0000
DEUTSCHE BANK (XET)	**8.8434**	0.0125	**0.4710**	0.0040
DEUTSCHE BOERSE (XET)	**21.9681**	0.0394	**1.1627**	0.0000
DEUTSCHE LUFTHANSA (XET)	**54.5187**	0.0000	**2.6158**	0.0000
DEUTSCHE POST (XET)	**22.1309**	0.0025	**1.0909**	0.0000
DEUTSCHE TELEKOM (XET)	**8.0162**	0.0041	**0.4150**	0.0149
E ON (XET)	**31.3427**	0.0000	**1.4122**	0.0000
FRESENIUS MED.CARE (XET)	**30.4931**	0.0069	**1.3959**	0.0000
HENKEL PREF (XET)	**29.2929**	0.0003	**1.5237**	0.0000
INFINEON TECHS. (XET)	**15.5705**	0.0022	**0.8804**	0.0000
LINDE (XET)	24.1001	0.2586	**1.1082**	0.0000
MAN (XET)	**29.7056**	0.0000	**1.4128**	0.0000
METRO (XET)	**36.1752**	0.0051	**1.8203**	0.0000
MUENCHENER RUCK. (XET)	**19.8201**	0.0004	**1.2661**	0.0000
RWE (XET)	**56.3598**	0.0000	**2.5025**	0.0000
SAP (XET)	**17.6130**	0.0023	**0.9272**	0.0001
SIEMENS (XET)	**30.3216**	0.0000	**1.6879**	0.0000
THYSSENKRUPP (XET)	**64.1515**	0.0000	**2.8934**	0.0000
TUI (XET)	**63.7790**	0.0000	**3.1412**	0.0000
VOLKSWAGEN (XET)	**29.6425**	0.0023	**1.7291**	0.0000

Table 3: Empirical results for DAX shares, $N = 1000$ days (up to 2006-11-10)

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Table 4: Empirical results for S&P 500, $N = 1000$ days (up to 2006-11-10)

Name	E_N	p_{E_N}	A	p_A
3M	6.2546	0.1113	0.2602	0.0621
ABBOTT LABS.	**8.8402**	0.0365	**0.5414**	0.0019
ACE	**33.1682**	0.0000	**1.6726**	0.0000
ADC TELECOM.	4.9564	0.6319	0.2120	0.1250
ADOBE SYSTEMS	**9.1182**	0.0068	**0.4051**	0.0050
ADVANCED MICRO DEVC.	4.1408	0.8349	0.2146	0.1072
AES	**17.8836**	0.0014	**0.9390**	0.0000
AETNA	**23.0169**	0.0093	**1.0513**	0.0000
AFFILIATED CMP.SVS."A"	9.8157	0.4695	**0.5712**	0.0005
AFLAC	**27.1956**	0.0000	**1.1067**	0.0001
AGILENT TECHS.	13.3442	0.3207	**0.4478**	0.0049
AIR PRDS.& CHEMS.	**22.0447**	0.0000	**1.1395**	0.0000
ALBERTO CULVER	**29.8082**	0.0001	**1.8378**	0.0000
ALCOA	**18.2157**	0.0097	**1.3829**	0.0000
ALLEGHENY EN.	**14.0358**	0.0082	**0.6781**	0.0004
ALLEGHENY TECHS.	7.2522	0.0723	**0.5517**	0.0017
ALLERGAN	**33.5021**	0.0000	**2.1750**	0.0000
ALLIED WASTE INDS.	**28.3839**	0.0000	**1.8795**	0.0000
ALLSTATE	9.7917	0.4627	**0.5377**	0.0025
ALLTEL	**23.7233**	0.0023	**1.2325**	0.0000
ALTERA	2.2625	0.3329	**0.3849**	0.0085
ALTRIA GROUP INCO.	6.3841	0.4273	**0.4618**	0.0108
AMAZON.COM	1.1978	0.8949	0.0976	0.6149
AMBAC FINANCIAL	**13.9098**	0.0322	**0.8142**	0.0001
AMER.ELEC.PWR.	**21.8756**	0.0000	**0.9966**	0.0000
AMER.POWER CONV.	**22.6129**	0.0027	**0.9974**	0.0001
AMER.STANDARD	**8.3348**	0.0308	**0.5542**	0.0009
AMEREN	**61.5621**	0.0000	**3.2637**	0.0000
AMERICAN EXPRESS	8.0145	0.0722	0.2824	0.0560
AMERICAN INTL.GP.	**16.4334**	0.0031	**0.8960**	0.0000
AMERISOURCEBERGEN	11.7503	0.8922	**0.6628**	0.0000
AMGEN	1.5485	0.2158	0.0976	0.6329
ANADARKO PETROLEUM	**9.9701**	0.0032	**0.5872**	0.0006
ANALOG DEVICES	9.6740	0.6749	**0.6642**	0.0005
ANHEUSER-BUSCH COS.	**29.8680**	0.0000	**1.0749**	0.0000

Name	E_N	p_{E_N}	A	p_A
AON	5.6623	0.1226	**0.3753**	0.0162
APACHE	**20.4182**	0.0000	**1.4121**	0.0000
APARTMENT INV.MAN."A"	**46.7200**	0.0000	**2.6805**	0.0000
APOLLO GP."A"	4.2808	0.2755	**0.3177**	0.0233
APPLE COMPUTER	**9.4612**	0.0291	**0.4692**	0.0015
APPLERA APPD.BIOS.	3.5700	0.3070	**0.2844**	0.0461
APPLIED MATS.	1.1197	0.8622	0.0514	0.9570
ARCHER-DANLS.-MIDL.	**20.7691**	0.0000	**1.0851**	0.0000
ARCHSTONE SMITH TST.	**71.1051**	0.0000	**3.3293**	0.0000
ASHLAND	**17.4926**	0.0072	**1.0395**	0.0000
AT&T	**17.8286**	0.0139	**1.1477**	0.0000
AUTODESK	**23.8816**	0.0005	**1.1805**	0.0000
AUTOMATIC DATA PROC.	10.3103	0.4897	**0.4573**	0.0054
AUTONATION	10.4046	0.7027	**0.5827**	0.0029
AUTOZONE	8.6420	0.1576	**0.4698**	0.0016
AVAYA	7.3556	0.5558	**0.3693**	0.0146
AVERY DENNISON	**17.6328**	0.0022	**1.1051**	0.0000
AVON PRODUCTS	**19.2913**	0.0040	**1.0370**	0.0000
BAKER HUGHES	**8.9307**	0.0105	**0.5917**	0.0008
BALL	**30.3833**	0.0000	**1.7684**	0.0000
BANK OF AMERICA	2.9382	0.0901	**0.3785**	0.0089
BANK OF NEW YORK CO.	4.0052	0.4023	**0.3163**	0.0335
BARD C R	**47.8468**	0.0000	**2.5467**	0.0000
BARR PHARMACEUTICALS	**21.9769**	0.0231	**1.2401**	0.0000
BAUSCH & LOMB	**26.1400**	0.0006	**1.7279**	0.0000
BAXTER INTL.	**24.9189**	0.0125	**1.3183**	0.0000
BB & T	**8.6630**	0.0052	**0.5318**	0.0025
BEAR STEARNS	5.5556	0.1840	**0.3757**	0.0107
BECTON DICKINSON	**23.5157**	0.0000	**1.1003**	0.0000
BED BATH & BEYOND	5.1305	0.0516	**0.3759**	0.0127
BELLSOUTH	**13.8365**	0.0099	**0.4199**	0.0113
BEMIS	**41.5849**	0.0000	**2.7285**	0.0000
BEST BUY	10.2638	0.6161	**0.5991**	0.0004
BIG LOTS	**20.0750**	0.0012	**1.3731**	0.0000
BIOGEN IDEC	2.1801	0.7623	0.1642	0.2438

Name	E_N	p_{E_N}	A	p_A
BIOMET	**12.4569**	0.0025	**0.8635**	0.0001
BJ SVS.	8.6227	0.0500	**0.6814**	0.0002
BLACK & DECKER	**39.9548**	0.0000	**2.4516**	0.0000
BMC SOFTWARE	9.4676	0.2158	**0.6048**	0.0009
BOEING	5.7367	0.5211	0.2509	0.0545
BOSTON PROPS.	**35.2672**	0.0000	**1.5343**	0.0000
BOSTON SCIENTIFIC	**26.0276**	0.0000	**1.3177**	0.0000
BRISTOL MYERS SQUIBB	**16.1119**	0.0306	**1.0358**	0.0000
BROADCOM "A"	1.1993	0.6438	0.1150	0.4510
BROWN-FORMAN "B"	**39.5241**	0.0000	**2.3862**	0.0000
BRUNSWICK	**11.7598**	0.0189	**0.6800**	0.0002
BURL.NTHN.SANTA FE C	**42.0085**	0.0000	**1.6802**	0.0000
CA	**11.9717**	0.0161	**0.7485**	0.0004
CAMPBELL SOUP	**38.8990**	0.0000	**1.9823**	0.0000
CAPITAL ONE FINL.	**16.7563**	0.0064	**0.9356**	0.0000
CARDINAL HEALTH	11.5433	0.8931	**0.4256**	0.0061
CAREMARK RX	**40.3698**	0.0000	**2.2647**	0.0000
CARNIVAL	7.2381	0.0860	**0.5372**	0.0011
CATERPILLAR	**7.7629**	0.0173	**0.4962**	0.0014
CBS "B"	**14.3130**	0.0323	**0.2918**	0.0333
CELGENE	**13.6150**	0.0054	**0.6281**	0.0008
CENTEX	**37.4711**	0.0000	**2.1723**	0.0000
CENTURYTEL	**12.2282**	0.0056	**0.7580**	0.0001
CHARLES SCHWAB	10.9946	0.2360	**0.5169**	0.0017
CHESAPEAKE ENERGY	**39.8995**	0.0000	**2.1464**	0.0000
CHEVRON	2.7358	0.5403	0.2507	0.0666
CHUBB	16.6676	0.0586	**0.8708**	0.0000
CIENA	7.1595	0.1035	**0.6204**	0.0005
CIGNA	13.8444	0.0946	**0.3926**	0.0126
CINCINNATI FIN.	**57.6855**	0.0000	**2.9168**	0.0000
CINTAS	**19.1203**	0.0496	**0.8905**	0.0001
CIRCUIT CITY STORES	6.3152	0.7449	**0.3215**	0.0315
CISCO SYSTEMS	**27.0658**	0.0000	**0.8057**	0.0001
CIT GP.	18.2757	0.4063	**0.7275**	0.0003
CITIGROUP	1.1129	0.6207	0.2403	0.0915

Name	E_N	p_{E_N}	A	p_A
CITIZENS COMMS.	**4.0767**	0.0454	0.1588	0.3049
CITRIX SYS.	**20.5316**	0.0143	**0.9757**	0.0001
CLEAR CHL.COMMS.	8.9564	0.5421	**0.6325**	0.0003
CLOROX	**16.8273**	0.0003	**1.1363**	0.0000
CMS ENERGY	**19.3136**	0.0001	**1.0933**	0.0000
COACH	**35.1820**	0.0000	**1.6978**	0.0000
COCA COLA	**19.5825**	0.0134	**1.0109**	0.0000
COCA COLA ENTS.	**32.3693**	0.0000	**1.7382**	0.0000
COLGATE-PALM.	**17.0361**	0.0075	**1.1646**	0.0000
COM.BANC.	**30.2669**	0.0000	**2.0426**	0.0000
COMCAST "A"	**5.5448**	0.0184	0.2117	0.1217
COMERICA	**21.7094**	0.0003	**1.6329**	0.0000
COMPASS BANCSHARES	**12.4782**	0.0003	**0.6002**	0.0008
COMPUTER SCIS.	**19.2678**	0.0014	**1.1753**	0.0000
COMPUWARE	5.7329	0.5998	0.2774	0.0628
COMVERSE TECH.	**18.6523**	0.0002	**0.9520**	0.0001
CONAGRA FOODS	**30.7821**	0.0000	**1.2897**	0.0000
CONOCOPHILLIPS	6.0737	0.3762	**0.4550**	0.0043
CONSOL EN.	22.2538	0.8463	**1.4539**	0.0000
CONSOLIDATED EDISON	**30.2309**	0.0000	**1.2196**	0.0000
CONSTELLATION BRANDS "A"	**23.3814**	0.0006	**1.5148**	0.0000
CONSTELLATION EN.	**21.7535**	0.0000	**1.0336**	0.0000
CONVERGYS	**15.8877**	0.0022	**0.9884**	0.0000
COOPER INDS.	**23.6585**	0.0032	**1.3322**	0.0000
CORNING	5.3667	0.3170	**0.2892**	0.0354
COSTCO WHOLESALE	2.7812	0.6861	0.1802	0.1928
COUNTRYWIDE FINL.	**11.6125**	0.0133	**0.7761**	0.0000
COVENTRY HLTHCR.	37.7293	0.0717	**1.8680**	0.0000
CSX	**30.0476**	0.0000	**1.5439**	0.0000
CUMMINS	**36.9546**	0.0003	**2.0710**	0.0000
CVS	**33.7663**	0.0000	**1.9781**	0.0000
D R HORTON	**29.3324**	0.0000	**2.0029**	0.0000
DANAHER	**23.2924**	0.0000	**1.2416**	0.0000
DARDEN RESTAURANTS	**13.4415**	0.0057	**0.8187**	0.0000
DEAN FOODS NEW	**14.6298**	0.0141	**0.8170**	0.0004

Name	E_N	p_{E_N}	A	p_A
DEERE	**16.5714**	0.0021	**1.0174**	0.0000
DELL	**11.6966**	0.0008	**0.4228**	0.0111
DEVON ENERGY	5.7943	0.1234	**0.4219**	0.0060
DILLARDS "A"	9.3670	0.2104	**0.7282**	0.0005
DOLLAR GENERAL	9.5714	0.0551	**0.5494**	0.0020
DOMINION RES.	**13.2846**	0.0005	**0.6137**	0.0009
DONNELLEY R R & SONS	**54.2857**	0.0000	**2.9219**	0.0000
DOVER	**17.0646**	0.0002	**1.0276**	0.0000
DOW CHEMICALS	**15.2860**	0.0120	**1.1450**	0.0000
DOW JONES & CO	**29.0114**	0.0002	**2.2576**	0.0000
DTE ENERGY	**12.9943**	0.0003	**0.6704**	0.0003
DU PONT E I DE NEMOURS	8.0737	0.2296	**0.4032**	0.0119
DUKE ENERGY	2.4448	0.1482	**0.2781**	0.0381
DYNEGY "A"	1.7556	0.8010	0.1676	0.2809
E TRADE FINL.	7.4847	0.0777	**0.3534**	0.0142
EASTMAN CHEMICALS	**51.1846**	0.0000	**2.8563**	0.0000
EASTMAN KODAK	**16.9167**	0.0247	**1.2123**	0.0000
EATON	**16.0222**	0.0083	**1.4258**	0.0000
EBAY	0.5247	0.4780	0.0720	0.7976
ECOLAB	**19.9913**	0.0015	**1.1883**	0.0000
EDISON INTL.	**12.4205**	0.0098	**0.6405**	0.0002
EL PASO	9.9168	0.0860	**0.5521**	0.0008
ELECTRONIC ARTS	7.4525	0.2516	**0.4068**	0.0173
ELECTRONIC DATA SYSTEMS	**16.5906**	0.0054	**0.8475**	0.0002
ELI LILLY	9.3321	0.0840	**0.4632**	0.0034
EMC	8.4897	0.1106	**0.2873**	0.0459
EMERSON ELECTRIC	2.0130	0.8943	0.1793	0.2267
ENTERGY	11.1018	0.7936	**0.4730**	0.0030
EOG RES.	**17.8651**	0.0099	**1.0048**	0.0000
EQUIFAX	**16.9527**	0.0000	**0.8769**	0.0001
EQUITY OFFE.PROPS.TST.	**9.5468**	0.0022	**0.3190**	0.0341
EQUITY RESD.TST.PROPS. SHBI	**33.4419**	0.0000	**1.5701**	0.0000
ESTEE LAUDER COS."A"	**25.4061**	0.0454	**1.0419**	0.0000
EXELON	**9.1684**	0.0356	**0.5165**	0.0019
EXPRESS SCRIPTS "A"	9.8127	0.8335	**0.3831**	0.0146

Name	E_N	p_{E_N}	A	p_A
EXXON MOBIL	0.3666	0.6213	0.1125	0.5279
FAMILY DOLLAR STORES	**21.5754**	0.0001	**1.1659**	0.0000
FANNIE MAE	10.4133	0.3287	**0.7044**	0.0002
FEDERATED DEPT.STRS.	11.4414	0.8522	**0.7873**	0.0000
FEDERATED INVRS.”B”	**21.5709**	0.0022	**1.4328**	0.0000
FEDEX	**41.2558**	0.0000	**1.7505**	0.0000
FIFTH THIRD BANCORP	3.4472	0.7874	0.1752	0.2215
FIRST DATA	8.7790	0.6852	**0.3549**	0.0135
FIRST HORIZON NATIONAL	**23.2931**	0.0001	**1.5527**	0.0000
FIRSTENERGY	**27.1803**	0.0000	**1.1589**	0.0000
FISERV	4.3985	0.1035	0.2892	0.0556
FISHER SCIEN.INTL.	**23.0594**	0.0005	**1.3885**	0.0000
FLUOR	**30.8893**	0.0003	**1.4946**	0.0000
FORD MOTOR	13.0222	0.3028	**1.0116**	0.0000
FOREST LABS.	15.8703	0.1745	**0.9161**	0.0000
FORTUNE BRANDS	**35.5959**	0.0000	**2.1761**	0.0000
FPL GROUP	**15.8143**	0.0002	**0.5191**	0.0015
FRANK.RES.	**5.7030**	0.0414	**0.4995**	0.0018
FREDDIE MAC	**19.9733**	0.0021	**1.1644**	0.0000
FREEPORT-MCMOR.CPR.& GD. ”B”	**4.8942**	0.0316	**0.4733**	0.0020
GANNETT	6.7305	0.9846	**0.3455**	0.0205
GAP	9.4592	0.1579	**0.3972**	0.0092
GENERAL DYNAMICS	**20.2675**	0.0005	**1.0244**	0.0001
GENERAL ELECTRIC	0.6880	0.4774	0.1700	0.2657
GENERAL MILLS	**26.0401**	0.0001	**1.1046**	0.0000
GENERAL MOTORS	**45.0122**	0.0000	**2.1722**	0.0000
GENUINE PARTS	**57.8616**	0.0000	**2.9576**	0.0000
GENZYME	**7.7655**	0.0313	**0.4507**	0.0037
GILEAD SCIENCES	5.0210	0.1697	**0.2800**	0.0492
GOLDMAN SACHS GP.	5.4803	0.3992	**0.4499**	0.0024
GOODRICH	**52.4649**	0.0000	**2.7067**	0.0000
GOODYEAR TIRE & RUB.	**15.5456**	0.0044	**0.8618**	0.0000
GRAINGER W W	**26.2374**	0.0001	**1.6961**	0.0000

Name	E_N	p_{E_N}	A	p_A
H & R BLOCK	5.6544	0.2021	**0.3204**	0.0312
HALLIBURTON	**5.5863**	0.0186	**0.3465**	0.0183
HARLEY-DAVIDSON	**20.4986**	0.0003	**1.1817**	0.0000
HARMAN INTL.INDS.	**23.7763**	0.0012	**1.4369**	0.0000
HARRAHS ENTM.	**14.9538**	0.0191	**1.0407**	0.0000
HARTFORD FINL.SVS.GP.	17.4558	0.6814	**0.7721**	0.0002
HASBRO	**14.9456**	0.0005	**0.7729**	0.0000
HCA	**19.6745**	0.0051	**0.7420**	0.0003
HEALTH MAN.AS.A	**19.8089**	0.0283	**1.4254**	0.0000
HEINZ HJ	**23.0293**	0.0000	**0.9291**	0.0000
HERCULES	**6.3896**	0.0370	**0.3826**	0.0101
HESS	**21.6739**	0.0002	**1.0402**	0.0000
HEWLETT-PACKARD	**24.5315**	0.0000	**0.6673**	0.0004
HILTON HOTELS	**8.0732**	0.0092	**0.5954**	0.0009
HOME DEPOT	9.4188	0.9064	**0.5555**	0.0027
HONEYWELL INTL.	**7.5303**	0.0245	**0.3546**	0.0256
HUMANA	**20.3849**	0.0007	**1.3617**	0.0000
HUNTINGTON BCSH.	**19.6255**	0.0000	**0.9637**	0.0000
ILLINOIS TOOL WKS.	**16.1413**	0.0033	**1.0072**	0.0000
IMS HEALTH	**18.1771**	0.0001	**0.8479**	0.0005
INGERSOLL-RAND	3.6072	0.5443	**0.3360**	0.0200
INTEL	5.0703	0.0828	**0.2880**	0.0317
INTERNATIONAL BUS.MACH.	**51.6199**	0.0000	**1.3842**	0.0000
INTERPUBLIC GP.	**55.6980**	0.0000	**3.3121**	0.0000
INTL.FLAV.& FRAG.	**24.9283**	0.0000	**1.3003**	0.0000
INTL.PAPER	**8.7066**	0.0033	**0.3991**	0.0108
INTUIT	4.6462	0.6256	0.2200	0.1493
ITT	**11.7225**	0.0016	**0.6881**	0.0001
JABIL CIRCUIT	10.4157	0.5904	**0.7392**	0.0003
JANUS CAPITAL GP.	9.1864	0.0837	**0.4295**	0.0049
JDS UNIPHASE	0.1540	0.8793	0.1526	0.2733
JOHNSON & JOHNSON	**17.2789**	0.0104	**0.5882**	0.0009
JOHNSON CONTROLS	**33.6076**	0.0000	**1.8976**	0.0000
JONES APPAREL GROUP	14.4487	0.9729	**0.6658**	0.0005

Name	E_N	p_{E_N}	A	p_A
JP MORGAN CHASE & CO.	4.0569	0.5212	0.1663	0.2368
JUNIPER NETWORKS	**9.5768**	0.0415	**0.3342**	0.0152
KB HOME	**15.5596**	0.0018	**1.0208**	0.0000
KELLOGG	**24.0391**	0.0001	**1.5097**	0.0000
KEYCORP	**26.1533**	0.0000	**1.0213**	0.0000
KEYSPAN	**15.4351**	0.0000	**1.0269**	0.0000
KIMBERLY-CLARK	6.8179	0.4245	0.2546	0.0672
KIMCO REALTY	**49.8138**	0.0000	**2.0829**	0.0000
KINDER MORGAN KANS	**18.3628**	0.0007	**1.1178**	0.0000
KING PHARMS.	**23.7268**	0.0001	**1.3249**	0.0000
KLA TENCOR	0.7080	0.8643	0.0827	0.7446
KOHLS	**16.6734**	0.0012	**1.0873**	0.0000
KROGER	**50.4550**	0.0000	**2.2342**	0.0000
L3 COMMUNICATIONS	12.6316	0.0995	**0.6687**	0.0002
LABORATORY CORP AMER. HDG.	24.9496	0.6257	**0.9336**	0.0000
LEGG MASON	**45.9018**	0.0000	**2.7408**	0.0000
LEGGETT&PLATT	**58.6787**	0.0000	**2.5904**	0.0000
LEHMAN BROS.HDG.	1.7959	0.2517	0.2746	0.0505
LENNAR "A"	**27.3554**	0.0000	**1.6348**	0.0000
LEXMARK INTL.GP.A	9.7872	0.6487	**0.5187**	0.0027
LIMITED BRANDS	8.9238	0.0724	**0.5173**	0.0042
LINCOLN NAT.	**44.6654**	0.0000	**2.1067**	0.0000
LINEAR TECH.	1.4386	0.2367	0.2619	0.0601
LIZ CLAIBORNE	**19.3864**	0.0000	**1.3129**	0.0000
LOCKHEED MARTIN	13.0046	0.0691	**0.6668**	0.0005
LOEWS	**21.7416**	0.0005	**1.3580**	0.0000
LOUISIANA PACIFIC	**12.3185**	0.0131	**0.7841**	0.0002
LOWE"S COMPANIES	14.1336	0.0623	**0.6312**	0.0002
LSI LOGIC	2.7172	0.5788	0.2608	0.0638
LUCENT TECHNOLOGIES	4.8857	0.0691	**0.2977**	0.0330
M&T BK.	**36.4836**	0.0000	**2.3078**	0.0000
MANOR CARE	**11.4691**	0.0125	**0.8189**	0.0005
MARATHON OIL	**49.4766**	0.0000	**2.3008**	0.0000

Name	E_N	p_{E_N}	A	p_A
MARRIOTT INTL."A"	6.8796	0.0535	**0.4045**	0.0105
MARSH & MCLENNAN	1.5738	0.8528	0.2122	0.1406
MARSHALL & ILSLEY	**35.4393**	0.0000	**1.6164**	0.0000
MASCO	**7.8187**	0.0324	**0.4401**	0.0068
MATTEL	2.3038	0.1384	0.1634	0.2923
MAXIM INTEGRATED PRDS.	0.0465	0.8353	0.0783	0.7679
MBIA	**14.1597**	0.0010	**1.0658**	0.0000
MCCORMICK & CO NV.	**25.3380**	0.0004	**1.2867**	0.0000
MCDONALDS	5.3553	0.9833	**0.3088**	0.0248
MCGRAW-HILL	**23.8349**	0.0000	**1.0143**	0.0000
MCKESSON	7.7902	0.3601	**0.6676**	0.0002
MEADWESTVACO	**37.6060**	0.0000	**2.1002**	0.0000
MEDIMMUNE	17.5472	0.5833	**0.7926**	0.0000
MEDTRONIC	15.5724	0.7072	**0.5833**	0.0011
MELLON FINL.	**19.1909**	0.0001	**1.3060**	0.0000
MERCK & CO.	19.1671	0.1086	**0.9762**	0.0000
MEREDITH	**39.0536**	0.0000	**3.0455**	0.0000
MERRILL LYNCH & CO.	4.3750	0.4020	0.2350	0.0974
METLIFE	**27.7499**	0.0000	**1.3076**	0.0000
MGIC INVT	**31.9795**	0.0000	**2.1582**	0.0000
MICRON TECHNOLOGY	**19.6867**	0.0024	**1.3076**	0.0000
MICROSOFT	**21.0222**	0.0000	**0.8336**	0.0002
MILLIPORE	**22.5254**	0.0089	**1.3486**	0.0000
MOLEX	**17.2517**	0.0000	**0.8240**	0.0000
MOLSON COORS BREWING "B"	**21.0690**	0.0047	**1.6600**	0.0000
MONSANTO	16.6112	0.0865	**0.9296**	0.0000
MONSTER WORLDWIDE	**10.7255**	0.0184	**0.7669**	0.0003
MOODYS	4.2187	0.4053	0.2427	0.0708
MORGAN STANLEY	7.8232	0.9802	**0.3532**	0.0143
MOTOROLA	5.7633	0.1598	0.2169	0.1099
MURPHY OIL	**28.7293**	0.0003	**1.6652**	0.0000
MYLAN LABORATORIES	**21.3750**	0.0114	**1.1997**	0.0000
NABORS INDS.	**12.2607**	0.0005	**0.7183**	0.0001
NAT.CITY	5.5455	0.0778	**0.4270**	0.0070
NATIONAL OILWELL VARCO	**23.2301**	0.0000	**1.4013**	0.0000

Name	E_N	p_{E_N}	A	p_A
NATIONAL SEMICON.	**9.0850**	0.0356	**0.7787**	0.0000
NAVISTAR INTL.	**34.6851**	0.0000	**1.7836**	0.0000
NCR	9.9693	0.7048	**0.4657**	0.0023
NETWORK APPLIANCE	5.7108	0.6976	0.1788	0.1783
NEW YORK TIMES "A"	**22.3283**	0.0000	**1.4395**	0.0000
NEWELL RUBBERMAID	**26.3981**	0.0000	**1.4949**	0.0000
NEWMONT MINING	1.6810	0.9800	0.2170	0.1083
NICOR	**13.5231**	0.0019	**0.7348**	0.0002
NIKE "B"	18.8787	0.5982	**1.0502**	0.0000
NISOURCE	**48.1246**	0.0000	**2.1942**	0.0000
NOBLE	**14.7592**	0.0004	**0.6302**	0.0001
NORDSTROM	**24.7980**	0.0169	**1.3558**	0.0000
NORFOLK SOUTHERN	**32.4923**	0.0000	**1.4534**	0.0000
NORTH FORK BANCORP.	**12.0442**	0.0005	**0.6308**	0.0009
NORTHERN TRUST	3.2410	0.1452	**0.3252**	0.0316
NORTHROP GRUMMAN	11.6938	0.8122	**0.4838**	0.0036
NOVELL	**13.2346**	0.0222	**0.5840**	0.0003
NOVELLUS SYSTEMS	2.9074	0.3791	0.1132	0.4823
NUCOR	**17.3654**	0.0096	**1.1837**	0.0000
NVIDIA	1.8496	0.9380	0.1519	0.2495
OCCIDENTAL PTL.	**21.3203**	0.0000	**0.9130**	0.0000
OFFICE DEPOT	8.2998	0.5046	**0.5668**	0.0016
OFFICEMAX	8.8139	0.0927	**0.8027**	0.0000
OMNICOM GP.	**20.4842**	0.0013	**1.0292**	0.0000
ORACLE	**23.8182**	0.0000	**0.6312**	0.0005
PACCAR	**11.0206**	0.0025	**0.5862**	0.0006
PACTIV	**13.0244**	0.0019	**0.6420**	0.0005
PALL	**55.3503**	0.0000	**2.4769**	0.0000
PARAMETRIC TECH.	0.7966	0.3984	0.1453	0.3806
PARKER-HANNIFIN	**16.6080**	0.0009	**1.2359**	0.0000
PATTERSON COMPANIES	**17.6630**	0.0003	**0.9689**	0.0003
PAYCHEX	**26.5828**	0.0000	**1.6690**	0.0000
PENNEY JC	**15.7566**	0.0149	**0.8866**	0.0001
PEOPLES ENERGY	**28.0665**	0.0000	**1.6872**	0.0000

Name	E_N	p_{E_N}	A	p_A
PEPSI BOTTLING GP.	13.4244	0.2234	**0.8218**	0.0002
PEPSICO	7.4299	0.4276	0.2456	0.0932
PERKINELMER	8.2721	0.2892	**0.5734**	0.0012
PFIZER	14.4266	0.4448	**0.9207**	0.0000
PG & E	4.8597	0.1410	0.2051	0.1715
PHELPS DODGE	**10.6983**	0.0156	**0.8418**	0.0000
PINNACLE WEST CAP.	**52.6939**	0.0000	**2.4680**	0.0000
PITNEY-BOWES	**10.5601**	0.0041	**0.6391**	0.0011
PLUM CREEK TIMBER	**4.8549**	0.0284	0.2417	0.0847
PMC-SIERRA	**21.3178**	0.0001	**0.5116**	0.0010
PNC FINL.SVS.GP.	**28.5722**	0.0000	**1.3953**	0.0000
PPG INDUSTRIES	**15.6386**	0.0010	**0.8992**	0.0001
PPL	**30.2039**	0.0000	**1.1652**	0.0000
PRAXAIR	**20.4422**	0.0014	**1.0700**	0.0000
PRINCIPAL FINL.GP.	4.5390	0.4084	**0.3479**	0.0305
PROCTER & GAMBLE	5.0703	0.2389	0.2533	0.0891
PROGRESS ENERGY	**43.3588**	0.0000	**2.2422**	0.0000
PROGRESSIVE OHIO	7.4337	0.1038	**0.7026**	0.0002
PROLOGIS	**19.0069**	0.0001	**0.9268**	0.0001
PRUDENTIAL FINL.	3.8231	0.9400	0.2120	0.1369
PUB.SER.ENTER.GP.	**12.0236**	0.0058	**0.8440**	0.0001
PUBLIC STORAGE	**19.7403**	0.0002	**0.9573**	0.0000
PULTE HOMES	**22.8509**	0.0000	**1.3297**	0.0000
QLOGIC	**9.7168**	0.0103	0.2158	0.1283
QUALCOMM	**8.1792**	0.0289	0.2025	0.1193
QUEST DIAGNOSTICS	25.5404	0.0743	**0.7056**	0.0001
QWEST COMMS.INTL.	**41.9467**	0.0000	**2.1820**	0.0000
RADIOSHACK	9.0363	0.5676	**0.5385**	0.0022
RAYTHEON "B"	**16.1334**	0.0081	**0.8203**	0.0001
REGIONS FINL.NEW	**27.5884**	0.0000	**1.2232**	0.0000
REYNOLDS AMERICAN	26.6621	0.0612	**0.9979**	0.0001
ROBERT HALF INTL.	**31.9685**	0.0000	**1.9849**	0.0000
ROCKWELL AUTOMATION	10.4988	0.1592	**0.6303**	0.0004
ROCKWELL COLLINS	**27.9216**	0.0000	**1.4530**	0.0000

Name	E_N	p_{E_N}	A	p_A
ROHM & HAAS	**16.9933**	0.0000	**0.9548**	0.0000
ROWAN COS.	**14.6571**	0.0013	**0.7782**	0.0000
RYDER SYSTEM	**23.4149**	0.0002	**1.4914**	0.0000
SABRE HDG.	**35.4259**	0.0000	**1.8940**	0.0000
SAFECO	**8.6780**	0.0236	**0.6988**	0.0003
SAFEWAY	**12.6485**	0.0467	**0.6977**	0.0001
SANDISK	1.9179	0.8754	0.1790	0.1637
SANMINA-SCI	8.8717	0.1732	0.1950	0.1397
SARA LEE	**41.2469**	0.0000	**1.8075**	0.0000
SCHERING-PLOUGH	**17.9678**	0.0006	**1.0672**	0.0000
SCHLUMBERGER	6.8281	0.0722	**0.6412**	0.0003
SCRIPPS E W "A"	**18.2035**	0.0107	**1.1863**	0.0000
SEALED AIR	**15.4358**	0.0423	**1.1229**	0.0000
SEMPRA EN.	**16.1988**	0.0004	**0.7279**	0.0002
SHERWIN-WILLIAMS	**16.4715**	0.0047	**0.7460**	0.0001
SIGMA ALDRICH	**32.2865**	0.0000	**2.0411**	0.0000
SIMON PR.GP.	**42.4162**	0.0000	**1.3910**	0.0000
SLM	**9.4466**	0.0093	**0.6179**	0.0002
SMITH INTL.	**27.6446**	0.0000	**1.1969**	0.0000
SNAP-ON	**26.0419**	0.0000	**1.8430**	0.0000
SOLECTRON	15.7506	0.9064	**0.7747**	0.0002
SOUTHERN	**7.4197**	0.0227	**0.3774**	0.0238
SOUTHWEST AIRLINES	1.5498	0.5576	**0.3618**	0.0207
SOVEREIGN BANC.	**37.1451**	0.0000	**1.6026**	0.0000
SPRINT NEXTEL	16.1846	0.0699	**0.6718**	0.0002
ST.JUDE MED.	**28.1207**	0.0007	**1.7516**	0.0000
ST.PAUL TRAVELERS	**22.2717**	0.0000	**1.3701**	0.0000
STANLEY WORKS	**44.7570**	0.0000	**2.5019**	0.0000
STAPLES	10.3851	0.0633	**0.4824**	0.0034
STARBUCKS	3.5974	0.2868	**0.3869**	0.0127
STARWOOD HTLS.& RSTS. WORLDWIDE	**7.2824**	0.0391	**0.5423**	0.0014
STATE STREET	3.2994	0.8741	**0.3589**	0.0215
STRYKER	**31.6544**	0.0000	**1.4857**	0.0000
SUN MICROSYSTEMS	**18.7354**	0.0000	**0.6908**	0.0001
SUNOCO	**19.4681**	0.0005	**1.2403**	0.0000

Name	E_N	p_{E_N}	A	p_A
SUNTRUST BANKS	**38.3802**	0.0000	**1.5206**	0.0000
SUPERVALU	**37.9887**	0.0000	**1.9526**	0.0000
SYMANTEC	10.5773	0.2099	**0.4100**	0.0109
SYMBOL TECHS.	11.8477	0.5891	**0.8210**	0.0001
SYNOVUS FINL.	**47.9249**	0.0000	**1.8774**	0.0000
SYSCO	**7.8009**	0.0097	**0.4394**	0.0073
T ROWE PRICE GP.	**12.1183**	0.0014	**0.9096**	0.0001
TARGET	9.4021	0.5505	**0.6354**	0.0008
TECO ENERGY	**23.2969**	0.0000	**1.1157**	0.0000
TEKTRONIX	7.5709	0.4508	**0.7077**	0.0003
TELLABS	7.2400	0.5758	**0.2877**	0.0495
TEMPLE INLAND	6.4525	0.1415	**0.6173**	0.0002
TENET HLTHCR.	**17.6832**	0.0109	**1.1210**	0.0000
TERADYNE	8.3986	0.7901	**0.7619**	0.0000
TEXAS INSTS.	**19.7577**	0.0164	**0.6359**	0.0004
TEXTRON	19.9192	0.1192	**0.9545**	0.0000
THE HERSHEY COMPANY	**15.8501**	0.0059	**0.8812**	0.0000
THERMO ELECTRON	**25.9328**	0.0000	**1.1761**	0.0000
TIFFANY & CO	**17.1222**	0.0013	**0.9910**	0.0000
TIME WARNER	**19.8177**	0.0002	**0.4615**	0.0040
TJX COS.	6.2235	0.1967	**0.2884**	0.0486
TORCHMARK	**15.1826**	0.0018	**1.0189**	0.0000
TRANSOCEAN	**7.5285**	0.0109	**0.5688**	0.0003
TRIBUNE	4.4980	0.4944	**0.2856**	0.0487
TXU	12.2925	0.1294	**0.6476**	0.0006
TYCO INTL.	**16.7878**	0.0001	**0.4496**	0.0056
TYSON FOODS "A"	8.4468	0.8188	**0.4738**	0.0053
UNION PACIFIC	**17.0732**	0.0001	**0.7404**	0.0003
UNISYS	**9.6789**	0.0141	**0.6422**	0.0006
UNITED PARCEL SER.	**38.5004**	0.0000	**1.7255**	0.0000
UNITED TECHNOLOGIES	**9.3310**	0.0198	**0.6615**	0.0001
UNITEDHEALTH GP.	**15.4848**	0.0364	**0.8315**	0.0001
UNIVISION COMMS."A"	12.4259	0.1830	**0.8437**	0.0000
UNUMPROVIDENT	**23.2775**	0.0000	**1.3813**	0.0000

Name	E_N	p_{E_N}	A	p_A
US BANCORP	**13.3648**	0.0433	**0.7100**	0.0005
US.STEEL	6.3272	0.3979	**0.5423**	0.0014
UST	**31.5030**	0.0177	**1.4960**	0.0000
V F	**66.9906**	0.0000	**4.2809**	0.0000
VALERO ENERGY	**15.7317**	0.0003	**0.9398**	0.0000
VERISIGN	4.2738	0.4512	**0.3249**	0.0407
VERIZON COMMS.	**16.5334**	0.0004	**1.0356**	0.0000
VIACOM "B"	10.7305	0.0837	**0.2978**	0.0293
VORNADO REALTY TST.	**30.9723**	0.0000	**1.2636**	0.0000
VULCAN MATERIALS	**49.6145**	0.0000	**2.1633**	0.0000
WACHOVIA	**29.7077**	0.0003	**1.7598**	0.0000
WAL MART STORES	**10.2553**	0.0105	**0.3325**	0.0388
WALGREEN	4.8262	0.9867	**0.3429**	0.0287
WALT DISNEY	6.3383	0.5451	**0.3008**	0.0340
WASHINGTON MUTUAL	**23.3757**	0.0000	**1.2765**	0.0000
WASTE MAN.	**24.7207**	0.0000	**1.1835**	0.0000
WATERS	**14.5029**	0.0201	**0.8742**	0.0000
WATSON PHARMS.	11.1401	0.7565	**0.7127**	0.0005
WEATHERFORD INTL.	**40.9548**	0.0000	**1.8817**	0.0000
WELLPOINT	12.1036	0.0643	**0.7777**	0.0002
WELLS FARGO & CO	**5.1971**	0.0317	0.2865	0.0562
WENDY"S INTL.	**21.8046**	0.0000	**1.1772**	0.0000
WEYERHAEUSER	**12.0086**	0.0038	**0.7284**	0.0005
WHIRLPOOL	**58.8859**	0.0000	**3.5878**	0.0000
WHOLE FOODS MARKET	6.3813	0.3692	**0.4607**	0.0044
WILLIAMS COS.	**19.3595**	0.0004	**0.8672**	0.0001
WRIGLEY WILLIAM JR.	**75.3896**	0.0000	**3.4502**	0.0000
WYETH	**27.7474**	0.0066	**1.6912**	0.0000
XCEL ENERGY	**17.1168**	0.0000	**0.6807**	0.0004
XEROX	4.2329	0.5010	0.2130	0.1182
XILINX	0.2260	0.8311	0.1202	0.4483
XL CAP."A"	**30.7610**	0.0000	**1.8690**	0.0000
XTO EN.	**30.0121**	0.0000	**1.6016**	0.0000

Name	E_N	p_{E_N}	A	p_A
YAHOO	5.3654	0.2514	0.1410	0.3229
YUM! BRANDS	11.9275	0.0635	**0.7607**	0.0001
ZIMMER HDG.	**30.5426**	0.0000	**1.6409**	0.0000
ZIONS BANCORP.	**11.3658**	0.0008	**0.6104**	0.0003