

# Eurex Derivative Products in Alternative Investments: The Case for Managed Futures

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## Abstract

This report analyzes the potential benefits to CTAs of incorporating Eurex futures contracts as an investment vehicle. Results indicate that investment in Eurex futures contracts would have improved the performance of a CTA employing a standard momentum-type trading model during the 1992-2002 test period. We also show that these strategies would have improved returns and lowered volatility for an investor holding a typical stock/bond portfolio. Global stock indexes are highly correlated, but the returns from momentum strategies employed in these markets are surprisingly different. In particular, the DAX®, Nikkei 225, and Dow Jones EURO STOXX 50 Futures contracts seem more conducive to trend-following strategies than the S&P 500 and FTSE 100 Futures contracts.

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# 1. Introduction

Managed futures is an industry comprised of professional money managers known as commodity trading advisors (CTAs) who manage client assets on a discretionary basis using global futures and options markets as an investment medium. Managed futures provide exposure to international financial and commodity sectors while offering – through their ability to easily take both long and short positions – a means to gain exposure to risk and return patterns not easily accessible through investment in traditional stock and bond portfolios or other alternative investment strategies such as hedge funds. Academic research has shown that investments in managed futures strategies

- 1) reduce portfolio volatility risk,
- 2) enhance portfolio returns in economic environments in which traditional stock and bond investment media offer limited opportunities, and
- 3) participate in financial products and markets not available in traditional investor products.

The dominant trading strategy employed by CTAs is trend-following, a type of momentum strategy that seeks to identify and exploit longer-term trends in asset markets. Prior research has explored the use of momentum strategies in a number of traditional and alternative asset markets. Most of these studies find support for the use of momentum strategies in the absence of transactions costs, and many support their use after accounting for these costs. This report explores the performance of momentum strategies in equity index and fixed income futures contracts. Emphasis is placed on financial futures contracts listed on Eurex. The performance of momentum strategies for futures contracts on the Dow Jones EURO STOXX 50 Index, the DAX® Index, Euro Schatz, Euro Bobl, and Euro Bund are compared to the performance of similar strategies employed using other major stock index and fixed income futures contracts.

The paper is organized as follows: In the next section, we present a brief review of managed futures and the economic function of speculative capital in futures markets. Section 3 describes the data and methodology used in this study, while Section 4 presents findings as they relate to the performance of the futures contracts as an investment tool. Results show that Eurex products provide investment benefits for managed futures traders both as a diversifier for other non-Eurex trading strategies and also as an investment vehicle, which provides risk and return benefits to long-only stock and bond investments. Section 5 summarizes the results.

## 2. Managed Futures: An Overview

Among major alternative investment strategies, private equity, private debt, and venture capital may be said to derive their returns from the same general source – economic growth – as stocks and bonds, albeit with a risk premium for illiquidity and informational costs. Similarly, hedge funds hold predominantly long positions in stocks or bonds and may likewise have a claim on economic growth. Long-only commodity investment may likewise link expected returns with economic growth, in that unexpected increases in demand may lead to increases in price until increased supplies or production can be raised. In addition, futures-based long-only commodity investments may capture returns related to convenience yields that result from the hedging activities of corporations.

Managed futures are unique among alternative investment strategies in that the markets they trade – futures and options markets – are zero-sum games; that is, total losses equal gains on any given day. However, this fact does not restrict certain managed futures strategies from offering positive expected rates of return. Traders who employ strategies that are designed to offer liquidity or other benefits to commercial users of these markets may generate income in exchange for providing these services. Spurgin (2000) describes a model in which commercial hedgers on one side of a market (e.g., oil producers) prefer to hedge their production before the hedgers on the other side of the market (e.g., airlines) choose to lock in the cost of their inputs. Under certain conditions, this creates a demand for speculative capital in the market to employ a momentum strategy that will be, on average, profitable. There are other explanations for the significant returns generated by CTAs over the past few decades. For example, the return to managed funds can stem from the ability of managers to exploit imperfections in the markets for futures as well as the markets for the underlying cash instruments. Behavioral research (Silber (1984), Shiller (2003)) also provides explanations for price trends. Research on traditional investment vehicles (e.g., stocks, bonds, and currency) indicates that investors may underreact to information and, consequently, price trends may result. Also, research has shown that the government intervention in interest rate and currency markets may result in trending currency and interest rate markets (Acar and Satchell (1998), Neely (1997)).

### 3. Data and Methodology

Trend-following and long-only returns were computed for a number of futures contracts in four major market segments: Currencies, interest rates, physical commodities, and stock indexes. Daily returns are computed from January 1, 1992 to December 31, 2002, a total of eleven years of trading history. We also construct indexes representing the performance of each segment. The trend-following trading strategy is described in Spurgin (1999). The trading model employed in the index is quite simple: If the total return to the futures contract over the prior  $x$  days is positive, then the trading signal will be long. Otherwise, it will be short. Three different versions of this model are simultaneously traded for each futures contract, and the results are averaged to give the daily index return. The parameters for the three models are 15, 27, and 55 days. The same parameters are used for each futures contract. For more information about the trading model, its historical performance, and the index construction, please refer to the appendix.

In each market, the strategy holds positions in the two nearest-to-maturity contracts. The allocations to the two contracts are changed daily to maintain a constant weighted average time-to-maturity in each market. The market segment indexes follow the methodology in Spurgin et al. (2000). The market indexes use historic volatility to determine allocation to each futures market. The strategy allocates equal dollar risk to each market in the index. Index weights are revised daily. Formulas for estimating volatility and for computing the notional investment in each futures contract are given in the Spurgin et al. (2000) article. The trend-following futures indexes are:

- Currency Index (three contracts): Euro (CME), Japanese Yen (CME), and British Pounds (CME).
- Global Fixed Income (three contracts): Treasury Bonds (CBOT), Eurodollar (CME), and Euro Bunds (Eurex).
- Physical Commodity Index (five contracts): Crude Oil (NYMEX), Natural Gas (NYMEX), Gold (COMEX), Copper (COMEX), and Corn (CBOT).
- Global Equity Index (three contracts): S&P 500 (CME), FTSE 100 (LIFFE), and Nikkei 225 (OSX).

Two Eurex trend-following indexes are also constructed using the same trading model. Data was not available for two of these contracts for the full time period of 1992-2002. Euro Schatz and Dow Jones EURO STOXX 50 futures are computed for the period 1999-2002. For the full period 1992-2002, the Eurex fixed income contains Euro Bund and Euro Bobl and the Eurex equity index contains only the DAX®. For the second time period, 1999-2002, the fixed income index contains three contracts and the equity index includes two contracts.

- Eurex Fixed Income (three contracts): Euro Bund, Euro Bobl, and Euro Schatz
- Eurex Equity Index (two contracts): DAX® and Dow Jones EURO STOXX 50

### **3.1 Data Sources**

Futures prices from Eurex were obtained from Bloomberg. CME, CBOT, NYMEX, LIFFE, and OSX prices are from Datastream. Traditional investment indexes – the S&P 500 Index, Lehman Aggregate Bond Index, Dow Jones EURO STOXX 50 Index, and Lehman European Government Bond Index, are from Bloomberg.

## 4. Results and Discussion

Analytical tests on the benefits of using Eurex futures contracts in trend-following trading strategies are conducted using a number of different metrics. First, we show the performance of trend-following and long-only strategies for a number of stock index and fixed income futures contracts. We then show the performance of these contracts during rising, falling, and consolidating markets. Next, the trading performance of commodity, fixed income, stock index, and currency indexes are presented. We also show the performance of a broad-based CTA index and the performance of traditional stock and bond indexes. The asset allocation decision is analyzed from a number of different perspectives: Mean-variance optimization for portfolios that contain only trend-following futures contracts, optimization for combining these contracts with traditional assets, performance during market extremes, and correlation analysis.

### 4.1 Descriptive Statistics for Trend-following and Long-only Returns

As shown in Exhibit 1, employing a trend-following model in financial futures contracts significantly alters the properties of the return series. For example, while the trend-following returns to most of the fixed income futures contracts are of similar magnitude to long-only returns, the correlation of the trend-following strategies with Treasury (TSY) Bonds is much lower than long-only. Thus, as a portfolio asset, the trend-following strategy offers greater diversification.

The returns for stock index futures are less consistent than the fixed income returns. Trend-following returns for the DAX<sup>®</sup> and Nikkei 225 are much higher than the long-only returns, while trend-following returns for the FTSE 100 and S&P 500 are lower than long-only. For the 1999-2002 period, when stock prices fell considerably, the trend-following returns for all five stock indexes were higher than the long-only returns. The annual difference was most pronounced for the DAX<sup>®</sup> (23.4%), Nikkei 225 (14.3%), and Dow Jones EURO STOXX 50 (7.4%).

## Exhibit 1. Trend-Following vs. Buy-and-Hold for Commodity and Financial Futures Contracts

Panel A. 1992-2002

	Long-Only				Trend-Following Strategy				Diff. (Trend - Long)	
	Annual Return	Standard Deviation	Correlation S&P 500	Correlation TSY Bond	Annual Return	Standard Deviation	Correlation S&P 500	Correlation TSY Bond	Annual Return	Standard Deviation
<b>Equity Index</b>										
FTSE 100	3.2%	15.4%	74.2%	-10.4%	-1.5%	12.8%	-18.1%	13.6%	-4.7%	-2.7%
Nikkei 225	-8.0%	22.6%	40.7%	0.1%	7.8%	17.1%	-19.3%	1.5%	15.8%	-5.5%
S&P 500	6.4%	15.3%	100.0%	-3.7%	0.0%	13.2%	-12.4%	23.2%	-6.4%	-2.1%
DAX®	2.4%	23.4%	69.2%	-14.0%	13.3%	19.6%	-24.9%	19.5%	10.9%	-3.8%
<b>Fixed Income</b>										
TSY Bond	9.0%	8.3%	-3.7%	100.0%	5.1%	7.1%	0.7%	39.9%	-3.9%	-1.2%
LIBOR*	6.2%	1.9%	2.0%	50.2%	6.1%	1.7%	-3.7%	21.8%	-0.1%	-0.2%
Euro Bobl	7.7%	3.3%	-8.5%	60.8%	6.9%	2.9%	-10.6%	28.1%	-0.8%	-0.4%
Euro Bund	8.4%	5.1%	-2.9%	66.2%	7.7%	4.2%	-0.3%	31.3%	-0.7%	-1.0%

Panel B. 1999-2002

	Long-Only				Trend-Following Strategy				Diff. (Trend - Long)	
	Annual Return	Standard Deviation	Correlation S&P 500	Correlation TSY Bond	Annual Return	Standard Deviation	Correlation S&P 500	Correlation TSY Bond	Annual Return	Standard Deviation
<b>Equity Index</b>										
FTSE 100	-11.0%	16.6%	87.5%	-42.8%	-8.1%	15.4%	-41.1%	3.8%	2.9%	-1.2%
Nikkei 225	-10.0%	21.4%	53.9%	-12.7%	4.3%	16.4%	-15.4%	6.3%	14.3%	-5.0%
S&P 500	-11.0%	18.2%	100.0%	-38.8%	-7.4%	15.1%	-38.9%	23.9%	3.6%	-3.1%
DAX®	-16.6%	29.3%	79.7%	-40.6%	6.8%	26.1%	-44.0%	9.7%	23.4%	-3.2%
Dow Jones EURO STOXX 50	-11.2%	24.1%	80.7%	-43.4%	-3.7%	21.9%	-25.1%	6.1%	7.4%	-2.3%
<b>Fixed Income</b>										
TSY Bond	7.4%	8.7%	-38.8%	100.0%	3.3%	7.1%	-3.6%	40.6%	-4.2%	-1.6%
LIBOR*	5.1%	5.0%	-33.9%	78.9%	5.5%	4.2%	-12.0%	30.3%	0.4%	-0.8%
Euro Bobl	6.9%	2.1%	-11.3%	28.2%	6.6%	1.9%	-10.6%	7.1%	-0.3%	-0.2%
Euro Bund	5.8%	3.2%	-48.0%	78.4%	4.6%	3.1%	-24.4%	37.8%	-1.2%	-0.1%
Euro Schatz	4.9%	1.5%	-45.3%	70.2%	4.5%	1.4%	-35.1%	32.8%	-0.4%	-0.1%

\* Leveraged (10x) Position

#### **4.2 Returns During Rising, Falling, and Consolidating Markets**

Simple trend-following models cannot capture all of the details of trading a particular contract. However, it is generally the case that a trend-following model will succeed best in markets where prices generally keep rising once they are above their recent range, and keep falling when they are below their recent range. To test this hypothesis, we studied the returns of each futures contract in relation to three reference points. Following the approach of Spurgin (2001), if the current futures price was higher than the prices of 15, 27, and 55 days prior, then the contract was considered “above the recent range”. If the current price was below all three reference prices, it was defined as “below the recent range”. If the current price was above at least one reference price and below at least one reference price, that day was defined as “within the recent range”.

As shown in Exhibit 2, the DAX® is alone among major stock index futures in that returns are positive when prices have been above their recent range. All the major fixed income indexes show continued gains when prices are above their recent range. When prices are below their recent range, the DAX® and Nikkei 225 have negative returns while the FTSE 100 and S&P 500 have positive returns. This helps explain why the trend-following results for the S&P 500 and FTSE 100 were so low, while the DAX® and Nikkei 225 had positive returns.

## Exhibit 2. Comparison of Futures Returns During Rising, Consolidating and Declining Markets

Panel A. 1992-2002

	Price Above Recent Range (in percent)			Price Within Recent Range (in percent)			Price Below Recent Range (in percent)		
	Average Return	Standard Deviation	Days	Average Return	Standard Deviation	Days	Average Return	Standard Deviation	Days
<b>Equity Index</b>									
FTSE 100	-0.1	14.4	34.1	5.4	17.7	40.6	10.8	24.1	25.3
Nikkei 225	-5.3	20.3	24.7	0.7	22.0	39.1	-12.5	26.4	36.2
S&P 500	0.5	12.8	37.6	11.7	17.3	41.4	13.3	27.4	21.0
DAX®	19.4	17.3	37.0	1.1	21.8	39.4	-11.2	32.0	23.6
<b>Fixed Income</b>									
TSY Bond	11.6	8.5	40.3	4.9	9.2	37.5	11.6	9.9	22.2
LIBOR*	4.0	1.8	21.1	3.7	1.5	34.9	1.1	1.8	44.0
Euro Bobl	10.0	3.0	46.8	4.4	3.5	33.6	6.4	3.8	19.6
Euro Bund	11.2	4.6	44.6	5.0	5.4	37.1	7.3	6.5	18.4

Panel B. 1999-2002

	Price Above Recent Range (in percent)			Price Within Recent Range (in percent)			Price Below Recent Range (in percent)		
	Average Return	Standard Deviation	Days	Average Return	Standard Deviation	Days	Average Return	Standard Deviation	Days
<b>Equity Index</b>									
FTSE 100	-27.2	17.5	17.7	-20.5	19.4	47.9	2.8	27.1	34.5
Nikkei 225	-10.7	21.4	25.7	-5.2	22.3	37.0	-16.2	25.9	37.2
S&P 500	-43.6	17.0	21.3	-15.1	22.1	43.8	8.5	29.3	34.9
DAX®	-8.8	22.3	22.5	-25.9	26.2	43.7	-16.7	35.0	33.9
Dow Jones EURO STOXX 50	-43.3	22.7	26.7	5.0	27.3	42.8	-12.3	37.5	30.5
<b>Fixed Income</b>									
TSY Bond	6.0	9.5	36.0	-0.8	9.7	39.3	8.4	9.9	24.8
LIBOR*	0.2	1.8	20.1	-1.7	1.5	31.3	-4.6	1.9	48.7
Euro Bobl	4.2	3.2	38.5	-2.7	3.6	37.3	4.6	3.5	24.2
Euro Bund	4.2	4.7	36.2	-4.2	5.7	40.1	5.0	5.9	23.7
Euro Schatz	2.0	1.6	36.9	-0.7	1.6	37.2	1.4	1.6	25.8

\* Leveraged (10x) Position

### 4.3 Risk-adjusted Performance and Portfolio Returns

Investment theory has shown that assets should be compared on a risk-adjusted basis, and that the potential benefit of adding an asset to an existing portfolio may be measured by an asset's ability to improve a portfolio's Sharpe ratio. Results in Exhibit 3 show that, over the past eleven years (1992-2002), investment in a diversified portfolio of commodity trading advisors (CISDM CTA USD) provides stand-alone risk and return benefits generally similar to or better than existing U.S. and world stock and bond investments. The Sharpe ratios are as follows: CISDM CTA USD (.55), S&P 500 (.33), Lehman Brothers Government/Credit bond index (.85). For the trend-following indexes, the Global Fixed Income (1.10), Eurex Fixed Income (.89) and Physical Commodities (.89) had the best risk-adjusted performance.

**Exhibit 3. Descriptive Statistics of Index Performance, 1992-2002**

	Average Annual Return	Standard Deviation	Monthly Minimum	Monthly Maximum	Return / Standard Deviation	Sharpe Ratio	Correlation S&P 500
<b>Traditional Assets</b>							
S&P 500	9.2%	14.9%	-14.5%	9.8%	0.61	0.33	1.00
Lehman	7.5%	3.8%	-2.5%	3.9%	2.00	0.85	0.07
US Treasury bills	4.3%	4.6%	1.2%	6.4%	0.93		0.16
<b>Managed Futures</b>							
CISDM CTA USD	9.3%	9.2%	-5.6%	8.2%	1.02	0.55	-0.13
Global Equity Index	2.8%	9.9%	-6.0%	12.9%	0.28	-0.15	-0.26
Global Fixed Income	10.4%	5.5%	-3.9%	6.1%	1.88	1.10	-0.11
Physical Commodity Index	10.7%	7.3%	-5.6%	7.1%	1.48	0.89	-0.13
Currency Index	6.6%	5.4%	-3.1%	5.4%	1.23	0.43	-0.18
<b>Eurex Managed Futures</b>							
Eurex Equity Index	13.3%	19.6%	-11.2%	21.6%	0.68	0.46	-0.24
Eurex Fixed Income	7.2%	3.2%	-1.9%	2.9%	2.22	0.89	-0.06

**Exhibit 4. Descriptive Statistics of Portfolio Performance, 1992-2002**

	Average Annual Return	Standard Deviation	Monthly Minimum	Monthly Maximum	Return / Standard Deviation	Sharpe Ratio	Correlation S&P 500
<b>Portfolio I</b>	8.8%	9.2%	-8.0%	6.4%	0.96	0.49	0.99
<b>Portfolio II</b>	8.5%	3.4%	-1.7%	4.2%	2.49	1.23	-0.29
<b>Portfolio III</b>	11.3%	12.1%	-7.3%	13.9%	0.93	0.57	-0.24
<b>Portfolio IV</b>	8.8%	7.2%	-5.6%	5.1%	1.22	0.63	0.98
<b>Portfolio V</b>	9.5%	5.9%	-2.9%	6.1%	1.62	0.88	0.86
<b>Portfolio VI</b>	9.2%	4.4%	-2.8%	5.3%	2.07	1.09	-0.31
<b>Portfolio VII</b>	10.3%	8.6%	-4.4%	7.4%	1.20	0.69	-0.22

**Portfolio I:** Dow Jones EURO STOXX 50: 60%, Lehman 40%

**Portfolio II:** Global Equity Index 10%, Global Fixed Income 35%, Physical Commodity 20%, Currency 35%

**Portfolio III:** Eurex Equity Index 60%, Eurex Fixed Income 40%

**Portfolio IV:** Portfolio I 80%, Portfolio II 20%

**Portfolio V:** Portfolio III 20%, Portfolio IV 80%

**Portfolio VI:** Portfolio II 80%, Portfolio III 20%

**Portfolio VII:** CISDM CTA USD 60%, Portfolio III 40%

As shown in Exhibit 4, Portfolio IV (which includes the S&P 500, Lehman Bond as well as a global trend-following futures portfolio) has a higher Sharpe ratio (.63) than that of Portfolio I, a long-only stock and bond portfolio (.49). More importantly, when a Eurex-based trend-following portfolio is added to Portfolio IV, the Sharpe ratio increases to .88 (Portfolio V). The potential benefit of adding a Eurex futures based trend-following portfolio to an existing futures-based CTA program can be seen in that a portfolio of CISDM CTA USD plus the Eurex futures trend-following portfolio had a higher Sharpe ratio (.69) than that of the CTA USD alone (.55).

As shown in Exhibit 5, Eurex equity index and Eurex fixed income are often included in optimal Markowitz return/risk portfolios. In Panel 5A, when no restrictions are placed on the portfolio, the optimal portfolio included investment in the Eurex equity index trend-following portfolio. When optimal weights were constrained to include at least 30% stocks, and 20% bonds, the Eurex equity index received a large allocation.

**Exhibit 5. Optimal Allocations for Traditional & Alternative Asset Portfolio (EUR Denominated) Based on Risk Tolerance Criteria (1992-2002)**

Panel A: Optimal Weights with No Allocation Constraints:

Historical Risk, Return and Correlation Data

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	Dow Jones EURO STOXX 50	JP Morgan Euro	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.20%	4.47%	0.89%	0.69	94.54%						5.46%	
0.10%	3.16%	0.98%	1.07	65.78%						34.22%	
0.05%	2.24%	0.98%	1.53	23.53%				38.18%		38.29%	
0.03%	1.73%	0.94%	1.88	20.68%			10.63%	43.85%		24.84%	

Panel B: Optimal Weights with Constraint of at Least 50% on Portfolio I, 5% of Each Eurex Index

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	Dow Jones EURO STOXX 50	JP Morgan Euro	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.10%	3.16%	0.85%	0.94	66.57%	20.00%					8.43%	5.00%
0.05%	2.24%	0.94%	1.45	30.00%	20.00%			9.07%		35.93%	5.00%
0.03%	1.73%	0.89%	1.78	30.00%	20.00%			24.52%		20.48%	5.00%
0.02%	1.41%	0.80%	1.95	30.00%	20.00%		19.24%	9.69%	11.07%	5.00%	5.00%

Panel C: Optimal Weights with Constraint of at Least 50% on Portfolio II

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	Dow Jones EURO STOXX 50	JP Morgan Euro	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.10%	3.16%	0.92%	1.01	1.54%		5.00%	17.50%	10.00%	17.50%	48.46%	
0.08%	2.83%	0.91%	1.11	6.21%		5.00%	17.50%	10.00%	17.50%	43.79%	
0.05%	2.24%	0.88%	1.36	15.44%		5.00%	17.50%	10.00%	17.50%	34.56%	
0.02%	1.41%	0.82%	2.02	18.42%		5.00%	17.50%	24.06%	17.50%	17.52%	

**Exhibit 6. Optimal Allocations for Traditional & Alternative Asset Portfolio  
(USD Denominated) Based on Risk Tolerance Criteria (1992-2002)**

Panel A: Optimal Weights with No Allocation Constraints:

Historical Risk, Return and Correlation Data

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	S&P 500	Lehman Aggregate	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.20%	4.47%	1.14%	0.88	15.62%						84.38%	
0.10%	3.16%	1.07%	1.17	27.14%				9.56%		63.30%	
0.05%	2.24%	1.01%	1.56	27.16%				27.56%		45.28%	
0.03%	1.73%	0.97%	1.94	27.07%				39.37%		33.55%	

Panel B: Optimal Weights with Constraint of at Least 50% on Portfolio I,  
5% of Each Eurex Index

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	S&P 500	Lehman Aggregate	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.05%	2.24%	0.93%	1.44	30.00%	20.00%			2.30%		42.70%	5.00%
0.04%	2.00%	0.92%	1.58	30.00%	20.00%			7.19%		37.81%	5.00%
0.03%	1.73%	0.90%	1.79	30.00%	20.00%			13.28%		31.72%	5.00%
0.02%	1.41%	0.87%	2.12	30.00%	20.00%			22.36%		22.64%	5.00%

Panel C: Optimal Weights with Constraint of at Least 50% on Portfolio II

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	S&P 500	Lehman Aggregate	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.10%	3.16%	0.94%	1.03	1.18%		5.00%	17.50%	10.00%	17.50%	48.82%	
0.08%	2.83%	0.92%	1.13	5.56%		5.00%	17.50%	10.00%	17.50%	44.44%	
0.05%	2.24%	0.89%	1.38	13.77%		5.00%	17.50%	10.00%	17.50%	36.23%	
0.02%	1.41%	0.84%	2.06	18.64%		5.00%	17.50%	20.17%	17.50%	21.19%	

**4.4 Euro-Denominated Portfolio Performance**

In Exhibits 3-6, the results were presented in terms of a USD-based investor. In Exhibits 7-10, results are presented in terms of a euro-based investor. Results in Exhibit 7 show that trend-following strategies would have obtained positive Sharpe ratios as stand-alone investments. The one exception to this is global equity index.

### Exhibit 7. Descriptive Statistics of Index Performance, 1992-2002

	Average Annual Return	Standard Deviation	Monthly Minimum	Monthly Maximum	Return / Standard Deviation	Sharpe Ratio	Correlation Dow Jones EURO STOXX 50
<b>Traditional Assets</b>							
Dow Jones EURO STOXX 50	9.4%	16.8%	-14.1%	11.0%	0.56	0.31	1.00
JP Morgan Euro	9.0%	3.8%	-2.4%	3.4%	2.35	1.23	0.12
European Risk Free Rate	4.3%	4.1%	1.3%	6.3%	1.04		0.17
<b>Managed Futures</b>							
CISDM CTA USD	9.3%	9.2%	-5.6%	8.2%	1.02	0.55	-0.16
Global Equity Index	2.6%	10.0%	-6.2%	12.7%	0.26	-0.17	-0.27
Global Fixed Income	10.2%	5.6%	-3.8%	5.9%	1.82	1.05	-0.21
Physical Commodity Index	10.6%	7.3%	-5.7%	7.2%	1.45	0.86	-0.05
Currency Index	6.4%	5.4%	-2.8%	5.4%	1.18	0.39	-0.18
<b>Eurex Managed Futures</b>							
Eurex Equity Index	13.0%	19.6%	-11.1%	21.6%	0.66	0.44	-0.15
Eurex Fixed Income	7.0%	3.3%	-1.8%	2.8%	2.11	0.82	-0.15

Exhibit 8 shows the performance of various Euro-denominated portfolios. In Exhibit 8, Portfolio IV which includes the Dow Jones EURO STOXX 50 and JP Morgan Euro-denominated Bond Index as well as a global trend-following futures portfolio has a higher Sharpe ratio (.64) than that of Portfolio I, a long-only stock and bond portfolio (.52). More importantly, when a Eurex-based futures trend-following portfolio is added to Portfolio IV, the Sharpe ratio increases to .84 (Portfolio V).

### Exhibit 8. Descriptive Statistics of Portfolio Performance, 1992-2002

	Average Annual Return	Standard Deviation	Monthly Minimum	Monthly Maximum	Return / Standard Deviation	Sharpe Ratio	Correlation Dow Jones EURO STOXX 50
<b>Portfolio I</b>	9.6%	10.4%	-7.7%	6.4%	0.93	0.52	0.99
<b>Portfolio II</b>	8.3%	3.5%	-1.6%	4.0%	2.36	1.14	-0.31
<b>Portfolio III</b>	11.0%	12.2%	-7.2%	13.9%	0.90	0.55	-0.17
<b>Portfolio IV</b>	9.5%	8.1%	-5.8%	5.2%	1.17	0.64	0.98
<b>Portfolio V</b>	10.0%	6.7%	-3.9%	6.3%	1.48	0.84	0.89
<b>Portfolio VI</b>	8.9%	4.5%	-2.7%	5.1%	1.98	1.03	-0.28
<b>Portfolio VII</b>	10.2%	8.6%	-4.4%	7.4%	1.18	0.68	-0.20

**Portfolio I:** Dow Jones EURO STOXX 50: 60%, Lehman 40%

**Portfolio II:** Global Equity Index 10%, Global Fixed Income 35%, Physical Commodity 20%, Currency 35%

**Portfolio III:** Eurex Equity Index 60%, Eurex Fixed Income 40%

**Portfolio IV:** Portfolio I 80%, Portfolio II 20%

**Portfolio V:** Portfolio III 20%, Portfolio IV 80%

**Portfolio VI:** Portfolio II 80%, Portfolio III 20%

**Portfolio VII:** CISDM CTA USD 60%, Portfolio III 40%

The basis for these results is due primarily to the correlation among the various trend-following futures programs and between those programs and traditional long-only investments. As shown in Exhibit 9, the correlation between the Dow Jones EURO STOXX 50 and each of the futures-based trading programs was negative. Likewise the correlation between the JP Morgan Euro Bond Index and each of the various futures-based programs is low. Similarly, the correlation between the two Eurex trend-following programs and other trend-following programs indicate the potential risk reduction from combining Eurex based-trend-following trades. Exhibit 9 also shows the diversification benefits of adding the two Eurex-based contracts if both are traded with a trend-following system (e.g. correlation of .24).

**Exhibit 9. Correlations (1992-2002)**

	Dow Jones EURO STOXX 50	JP Morgan Euro	US Treasury bills	CISDM CTA USD	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
Dow Jones EURO STOXX 50	1.00									
JP Morgan Euro	0.12	1.00								
US Treasury bills	0.17	-0.01	1.00							
CISDM CTA USD	-0.16	0.28	-0.02	1.00						
Global Equity Index	-0.27	0.19	-0.04	0.25	1.00					
Global Fixed Income	-0.21	0.28	-0.09	0.52	0.28	1.00				
Physical Commodity Index	-0.05	0.09	0.04	0.25	0.20	-0.08	1.00			
Currency Index	-0.18	0.09	-0.03	0.56	0.01	0.07	0.02	1.00		
Eurex Equity Index	-0.15	0.17	-0.13	0.34	0.56	0.36	0.02	0.13	1.00	
Eurex Fixed Income	-0.15	0.35	-0.07	0.46	0.21	0.69	0.11	0.05	0.24	1.00

As shown in Exhibit 10, Eurex equity index and Eurex fixed income are often included in optimal Markowitz return/risk portfolios. As shown in Panel 10A, when no restrictions are placed on historical optimal portfolio, the Eurex equity trend-following index receives a large allocation. Even when optimal weights were constrained to include at least 50% in Portfolio I (stocks and bonds), both the Eurex equity index and fixed income trend-following systems were included in various optimal return/risk portfolios.

**Exhibit 10. Optimal Allocations for Traditional & Alternative Asset Portfolio Based on Risk Tolerance Criteria (1992-2002)**

Panel A: Optimal Weights with No Allocation Constraints:

Historical Risk, Return, and Correlation Data

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	Dow Jones EURO STOXX 50	JP Morgan Euro	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.20%	4.47%	0.89%	0.41	94.54%						5.46%	
0.10%	3.16%	0.98%	0.68	65.78%						34.22%	
0.05%	2.24%	0.98%	0.97	23.53%				38.18%		38.29%	
0.03%	1.73%	0.94%	1.16	20.68%			10.63%	43.85%		24.84%	

Panel B: Optimal Weights with Constraints of at Least

50% on Portfolio I and 5% of Each Eurex Index

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	Dow Jones EURO STOXX 50	JP Morgan Euro	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.10%	3.16%	0.85%	0.54	66.57%	20.00%					8.43%	5.00%
0.05%	2.24%	0.94%	0.89	30.00%	20.00%			9.07%		35.93%	5.00%
0.03%	1.73%	0.89%	1.06	30.00%	20.00%			24.52%		20.48%	5.00%
0.02%	1.41%	0.80%	1.07	30.00%	20.00%		19.24%	9.69%	11.07%	5.00%	5.00%

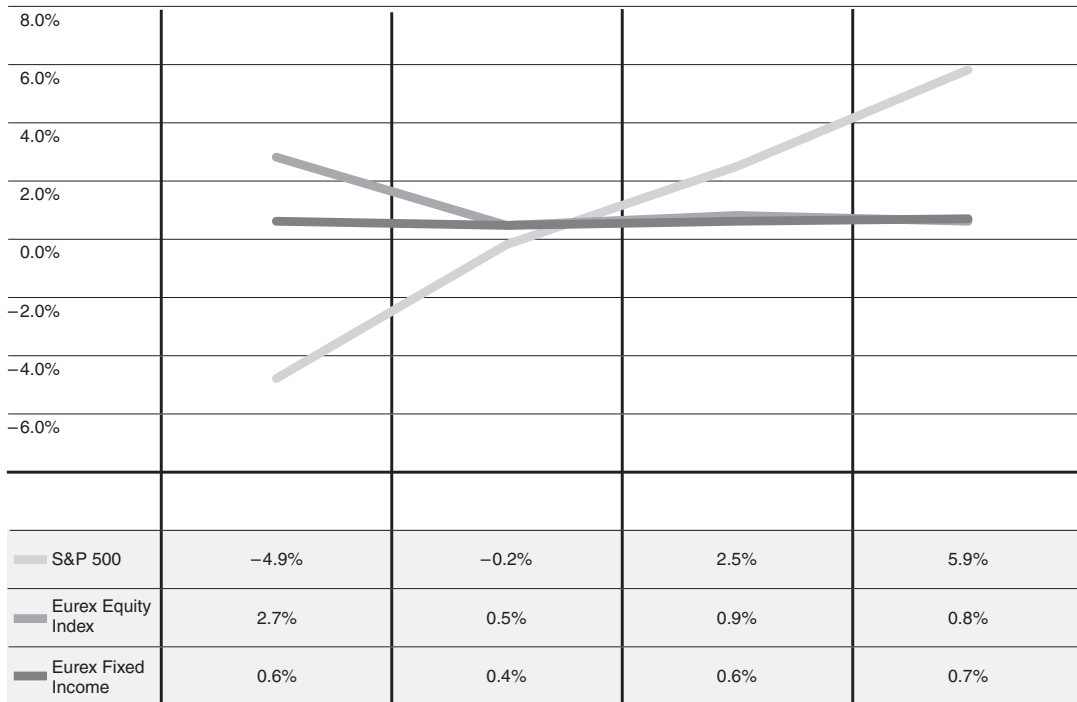
Panel C: Optimal Weights with Constraints of at Least 50% on Portfolio II

Variance Criteria	Monthly Standard Deviation	Monthly Return	Sharpe Ratio	Dow Jones EURO STOXX 50	JP Morgan Euro	Global Equity Index	Global Fixed Income	Physical Commodity Index	Currency Index	Eurex Equity Index	Eurex Fixed Income
0.10%	3.16%	0.92%	0.61	1.54%		5.00%	17.50%	10.00%	17.50%	48.46%	
0.08%	2.83%	0.91%	0.67	6.21%		5.00%	17.50%	10.00%	17.50%	43.79%	
0.05%	2.24%	0.88%	0.80	15.44%		5.00%	17.50%	10.00%	17.50%	34.56%	
0.02%	1.41%	0.82%	1.14	18.42%		5.00%	17.50%	24.06%	17.50%	17.52%	

#### 4.5 Performance of Trend-following Strategies During Market Extremes

Academic research (CISDM, 2003) has shown that certain managed futures strategies tend to have positive returns when equity markets have large negative returns. In Exhibit 11, the average monthly return of the S&P 500, Eurex equity Index, and Eurex fixed income are arranged into four groups of 33 months based on the return of the S&P 500. Group 1 is 33 worst months for the S&P 500 and Group 4 contains the highest returns. The period studied is 1992-2002. Results confirm previous academic research results (CISDM, 2003) that found high returns to trend-following futures programs during the worst months for the U.S. stock market. During the worst quartile of S&P 500 months, the Eurex equity index increased by an average of 2.7% – more than three times the average monthly return for the strategy – and the Eurex fixed income rose 0.6%, which was about average for the strategy over the full time period.

**Exhibit 11: Portfolio Returns Ranked on S&P 500 1992-2002**



## 5. Summary and Conclusions

This report analyzes the potential benefits to CTAs of incorporating Eurex futures contracts as an investment vehicle. Results indicate that investment in Eurex futures contracts would have improved the performance of a CTA employing a standard momentum-type trading model during the 1992-2002 test period. We also show that these strategies would have improved returns and lowered volatility for an investor holding a typical stock/bond portfolio. Global stock indexes are highly correlated, but the returns from momentum strategies employed in these markets are surprisingly different. In particular, the DAX®, Nikkei 225, and Dow Jones EURO STOXX 50 futures contracts seem more conducive to trend-following strategies than the S&P 500 and FTSE 100 futures contracts.

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# Appendix: Description of Trend-following Trading Strategy and Index Construction

## Trading Strategy

A momentum trading rule determines long and short positions in each market. An  $x$ -day momentum strategy takes a long position in a futures market on date  $t$  if the total return to the contract between dates  $t$  and  $t-x$  is positive. Otherwise the strategy takes a short position. Three separate momentum strategies are traded in each market. The numbers of days used to compute the momentum trading rules are 15, 27, and 55. Spurgin (1999) reports that this combination of momentum rules had the highest correlation with broad-based CTA indexes. Each strategy has an equal weight, so the index will either be 100% long, 33% long, 33% short, or 100% short in a given contract, depending on the signals of the three strategies. As is the norm for passive investment indexes, no fees, transaction costs, bid/ask spreads, or other market imperfections are assumed.

## Currency Conversion

Futures contracts do not require full collateralization of the underlying assets, so a USD investor can hold collateral in dollars and convert profits or losses in foreign-denominated assets at the end of each day. All assets are assumed collateralized in USD and all gains and losses from trading are converted to the base currency at the end of the day. Currency conversion rates are computed from daily returns to futures contracts traded on the CME.

## Leverage and Returns on Collateral

Returns on un-invested collateral are assumed to earn a money-market rate. US 3-Month Treasury yields are added to USD trading returns to allow a comparison between futures-based returns and returns for other traditional asset classes such as stocks and bonds. While many futures trading programs employ leverage, the trading indexes employed here are unleveraged – with one exception. The CME Eurodollar (LIBOR) contract is leveraged because the high notional value of this contract (USD 1 million) and small daily price changes results in such low return volatility that the results are often skewed. This contract is leveraged ten times (USD 100,000 in collateral is allocated to each USD 1 million notional contract) in order to produce return volatility that is consistent with other fixed income futures contracts.

## Method of Estimating Historic Volatility for Risk Allocation

The method of estimating historic volatility incorporates the average of the trading range (Parkinson, 1980). A period of 200 trading days is used to estimate volatility from observed trading ranges  $l$ .

The equation for the volatility of an individual commodity is

$$\sigma^2 = \frac{(\sum l_i / N)^2}{(8/\pi)} \quad (1)$$

### Computing Asset Allocations

In order to insure equal risk in each commodity, the percentage allocation ( $X_i$ ) to each of the  $n$  futures contracts must satisfy two constraints. The solution to this system of equations gives the notional amount of each underlying futures contract.

$$\text{Constraints: } X_i \sigma_i = C, \sum_{i=1}^n X_i = 1 \quad \text{Optimal Weights: } X_i = \frac{1}{n} \frac{1}{\sigma_i} \quad (2)$$

### Descriptive Statistics of Pro Forma Trading Results, 1992-2002

Annual returns for each equity index and fixed income futures contract were computed, along with the best month, worst month, largest peak-to-trough drawdown, and the number of months needed to recover from the largest drawdown. For the trend-following model, we also compute the average number of days between round turns and the average round turns per year. Results indicate that executing this strategy would require turning over the portfolio every 2-3 weeks.

### Exhibit A1: Descriptive Statistics of Long-Only and Trend-Following Strategy Returns, 1992-2002

#### Panel A. Long-Only Strategy

Annual Returns	Equity Index					Fixed Income				
	FTSE 100	Nikkei 225	S&P 500	DAX®	Dow Jones EURO STOXX 50	Treasury Bond	LIBOR	Euro Bobl	Euro Bund	Euro Schatz
1992	7.8%	-29.5%	6.8%	-8.2%		7.9%	5.2%	7.0%	7.3%	
1993	19.1%	0.6%	8.9%	39.5%		17.4%	4.2%	12.2%	9.1%	
1994	-9.1%	15.4%	0.6%	-9.1%		-7.1%	1.0%	-6.6%	-3.2%	
1995	22.3%	2.3%	36.2%	7.9%		31.0%	11.6%	20.6%	20.3%	
1996	15.0%	0.7%	21.1%	29.3%		-1.2%	5.5%	10.4%	9.9%	
1997	25.3%	-20.9%	30.2%	44.7%		13.9%	6.7%	12.6%	8.1%	
1998	10.0%	-8.4%	25.3%	14.1%		12.0%	6.6%	18.0%	11.1%	
1999	18.2%	42.7%	17.2%	37.3%	46.6%	-9.2%	2.7%	-3.9%	1.1%	3.3%
2000	-11.4%	-24.3%	-12.2%	-8.5%	-3.4%	22.6%	9.9%	12.3%	10.4%	7.3%
2001	-17.2%	-25.7%	-18.3%	-24.2%	-23.7%	2.1%	11.8%	2.7%	4.0%	4.6%
2002	-27.8%	-18.2%	-25.5%	-49.2%	-42.4%	17.2%	3.4%	10.1%	8.1%	4.5%
Best Month	10.5%	14.6%	9.0%	18.5%	13.6%	7.8%	2.9%	3.9%	2.8%	1.5%
Worst Month	-13.9%	-16.8%	-15.3%	-25.6%	-19.4%	-5.2%	-0.7%	-3.5%	-1.7%	-0.6%
Maximum Drawdown <sup>1</sup>	49.7%	59.9%	51.0%	67.8%	62.1%	11.4%	1.0%	8.8%	4.9%	1.3%
Maximum Drawdown Length <sup>2</sup>	37*	132*	29*	35*	33*	22	6	18	15	8

<sup>1</sup> Maximum Drawdown is largest peak-to-trough percentage decline.

<sup>2</sup> Maximum Drawdown Length is largest number of months between new highs, \*indicates longest drawdown had not ended as of 12/2002.

Panel B. Trend-Following Strategy

Annual Returns	Equity Index					Fixed Income				
	FTSE 100	Nikkei 225	S&P 500	DAX®	Dow Jones EURO STOXX 50	Treasury Bond	LIBOR	Euro Bobl	Euro Bund	Euro Schatz
1992	13.1%	7.4%	-9.2%	20.0%		2.2%	4.8%	5.6%	6.6%	
1993	-6.0%	30.8%	-11.6%	29.6%		10.0%	3.5%	10.3%	8.7%	
1994	7.9%	2.5%	0.1%	-5.7%		3.3%	6.7%	6.4%	7.9%	
1995	-7.9%	22.7%	25.2%	0.4%		20.7%	8.6%	12.2%	15.1%	
1996	-6.1%	2.8%	-1.3%	8.7%		-2.1%	5.0%	8.7%	6.8%	
1997	3.6%	15.1%	4.5%	37.9%		10.0%	4.8%	6.4%	4.7%	
1998	15.7%	-7.2%	31.4%	37.1%		1.2%	7.2%	13.4%	7.9%	
1999	-5.4%	-5.6%	-14.3%	-6.4%	9.8%	2.7%	4.6%	5.2%	4.1%	4.7%
2000	-20.3%	1.7%	-22.4%	-18.9%	-23.7%	10.5%	8.6%	6.2%	7.3%	6.5%
2001	2.3%	9.6%	11.2%	33.4%	10.4%	-3.2%	10.8%	6.6%	2.3%	3.5%
2002	-7.4%	12.4%	-0.7%	28.6%	-7.3%	3.5%	2.5%	3.9%	4.7%	3.4%
Best Month	11.8%	19.8%	16.4%	21.6%	14.7%	7.8%	2.7%	3.9%	2.8%	1.5%
Worst Month	-11.1%	-9.7%	-13.4%	-11.2%	-12.0%	-6.3%	-0.4%	-2.5%	-1.9%	-0.6%
Maximum Drawdown <sup>1</sup>	32.4%	21.2%	36.1%	33.8%	25.9%	10.1%	0.4%	3.4%	1.9%	0.8%
Maximum Drawdown Length <sup>2</sup>	50*	47	48*	45	37*	15	2	10	9	5
Average Position (Days) <sup>3</sup>	10.7	13.1	11.2	13.1	10.3	12.9	15.8	14.7	15.0	13.9
Round Turns Per Year <sup>4</sup>	24.2	19.9	23.2	19.8	25.3	20.1	16.5	17.7	17.3	18.7

<sup>1</sup> Maximum Drawdown is largest peak-to-trough percentage decline.

<sup>2</sup> Maximum Drawdown Length is largest number of months between new highs, \*indicates longest drawdown had not ended as of 12/2002.

<sup>3</sup> Average Position (Days) is the average holding period for a round turn using the trend-following model.

<sup>4</sup> Round Turns Per Year is the average annual turnover, in round futures turns, for the trend-following model.

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