EVALUATION OF THE PAIRS TRADING STRATEGY IN THE CANADIAN MARKET

By

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1 INTRODUCTION

Pairs trading is a popular technical trading strategy that obtains profit by taking advantage of mispricings in the market. It is one of the oldest market neutral strategies used by portfolio managers. The success of this technique which began in the largest equity market in the world, the United States, coupled with the increasing availability of cheap computing power led to the development "proprietary" pairs trading algorithm as one of the basic tools among hedge funds and institutional investment house today. Since pairs trading strategies are currently being employed in stock markets around the world, this paper seeks to examine the robustness of excess returns in a smaller market as Canada in the recent period from 1983-2009.

As opposed to traditional investing, pairs trading does not seek to determine the absolute price of any stock to figure out the whether it is overvalued or undervalued. The "Law of One Price" states that stocks with the same risk factors should have the same price. Accordingly, two stocks with similar characteristics must have the same price even if that price is wrong. This relative pricing is the premise of pairs trading. The basic process involves finding two stocks that move together. When their prices diverge significantly, the more expensive stock is sold short while the cheap stock is bought. Positions are closed when the pairs converge and a profit is made. This convergence of stock prices relate to the mean reversion documented by DeBondt and Thaler (1985, 1987) and Jegadeesh and Titman (1993).

Gatev, Goetzmann and Rouwenhorst (2006) present evidence that employing a simple trading strategy produced statistically significant excess returns for the period 1962-2002 in the US market. The result of the Gatev et al.(2006) paper was replicated by Do and Faff (2009) whose paper reconstructed and documented the algorithm upon which this research paper is largely based.

This paper is organized as follows: Section I is the introduction. In Section II, we describe the data and data issues. The methodology in the formation of pairs and the trading strategy and the excess return calculations are also discussed. Section III contains the results. Finally, section IV is the conclusion.

2 DATA AND METHODOLOGY

2.1 Data

The historical return data of many of the securities in the Canadian market is not always available. To include as many of the stocks in as long a time period as possible, we have chosen the 1993-2009 period with 36 securities. The composition of the sample data is eight securities in the Financials sector, ten securities each in the Energy and Materials sector, the rest in Health Care, Consumer Discretionary and Information Technology. The Canadian stock market is heavily weighted in the material sector whose availability of historical data is limited and non-trading days frequent.

Given the dearth of a comprehensive source of securities data in the Canadian market, total return data cum dividends for S&PTSX index members are collected from Bloomberg for the period from January 1983 through 29September 2009. Securities with discontinuous trading periods, incomplete trade data and six-month average trading volume of less than 500,000 are filtered out.

2.2 Methodology

2.2.1 Pairs Formation

In the pairs formation phase of one year or exactly 252 days, we begin by bringing the asset prices to the same unit price of $1 called price normalization. This process involves constructing a cumulative total return index for each stock in the sample. An exhaustive matching is done among the different securities to find pairs that move together using the sum of the squared difference between two asset prices. The pairs are sorted based on the minimum of the squared difference of their normalized prices. The top 5 pairs comprise the Top 5 Portfolio. The top 20 pairs make up the Top 20 portfolio. The formation periods are staggered by one month.

2.2.2 Trading Period

After pairs are formed, they are traded in the subsequent six-month period or 126 days. The stock prices are normalized again for the trading period beginning on the first day after the pairs formation period. The trigger for opening a position is when the prices of our chosen pairs in this trading period diverge by at least two standard deviations. The standard deviation is calculated on the difference between their normalized prices. An initiating trade is defined by taking a long position in the cheaper stock price while simultaneously taking a short position in the higher priced stock. This position remains open until the pairs' prices converge or cross. On convergence, the short position is closed by buying the stock and the long position by selling the stock. The pairs may open and close several times in the trading period or not at all. If an open position does not converge by the end of the trading period, we force the closing of the position on the last day of trading at that day's price. There are 181 trading periods from 1993-2009.

2.2.3 Excess Return Computation

Self-Financing Strategy

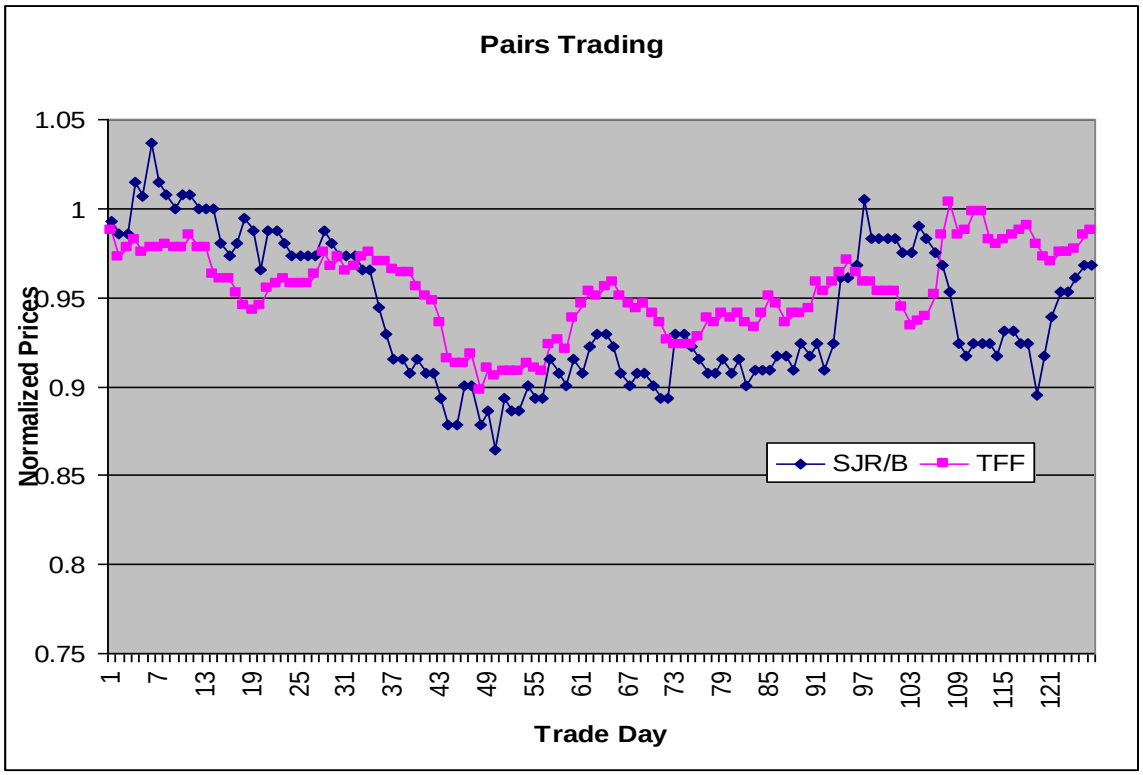
The excess return computation for one pair is based on a 6 month trading period where there may be several trades or none for each pair of stock. This basic calculation of the returns assumes a self-financing portfolio where all stocks are infinitely divisible and there is no transaction cost. The proceeds from the short sale are fully invested by purchasing an equivalent dollar amount of the cheap stock. At convergence, two trades happen, the cheap stock is sold and the short position is covered. The difference in the cash flows on the convergence trade is the payoff. The return on the long position less the return on the short position is the excess return of this pair. The calculation is as follows:

$$r_t^{AB} = I_t^{AB} \cdot \left(r_t^B - r_t^A\right)$$

$$I_t^{AB} \equiv \begin{array}{cc} 0 & \text{not open} \\ +1 & \text{short A; long B} \\ -1 & \text{long A; short B} \end{array}$$

A Pairs Trading Example

The following is an example of a pairs trading strategy from the sample data. Figure 1 shows the normalized prices for the two stocks in the trading period. On day 6, the pairs diverge by more than 2 standard deviations and an initial position is opened. Stock A is sold short while Stock B is bought. On day 33, the pairs cross and positions are closed at the convergent prices. This one complete trade gains on the short position by 6.8% and loses on the long position by 0.5% for a profit of 6.3%. Over the 6 month trading period, the pairs traded 3 complete cycles. Note that in the 4th cycle, prices did not cross nor converge prior to the last trading day, we therefore force closed at day 126 at that day's prices. The cumulative profit for this one pair during this trading period is 24.8% over six months.



					RETURN	
Dates	Trade Day	SJR/B	FTT		Long	Short
19940425	6	1.0365	-0.9774	1	0	0
19940603	33	-0.9659	0.9725	0	0.0681	-0.0051
19940613	39	-0.9078	0.9634	1	0	0
19940729	73	0.9296	-0.9231	0	0.0240	0.0419
19940913	104	0.9903	-0.9365	1	0	0
19940916	107	-0.9683	0.9851	0	0.0222	0.0519
19940920	109	-0.9243	0.9851	1	0	0
19941013	126	0.9683	-0.9876	-1	0.0476	-0.0026

Portfolio Approach

In the example provided above, the profit calculation is based on a single pair in a frictionless arbitrage point of view. In the portfolio approach to calculating returns, we take into consideration the capital that is employed or set aside to generate excess return. The excess return per trading period in the portfolio approach is measured in two ways. One is the return on committed capital which is the sum of all payoffs in the trading period divided by the number of pairs in the portfolio. The other is the return on invested capital where payoffs are divided by the number of pairs that actually trade.

$$r_t^{port} = \frac{1}{n} \sum_{pair=1}^{n} r_t^{AB,pair}$$

We use this return calculation to analyze the excess returns on three types of portfolios: the Top 5, Top 20 and the Top 101-120 pairs such that the divisor for the return calculation is 5, 20 and 20 respectively for the return on committed capital.

3 EMPIRICAL RESULTS

3.1 Strategy Profits

Table I presents the annualized mean returns and other statistics for the pairs portfolios wherein pairs do not necessarily belong to the same sector. The table is divided into three panels. The top panel is the excess return of the portfolio of the top 5 pairs, followed by the excess return of the portfolio of the top 20 pairs in the middle panel and in bottom panel, the top 101-120 pairs. The columns are also divided into three. The first column is the excess return for the full period from 1993-September 2009. The sub-period results are provided in the middle column and last columns for 1993-2003 and 2004-2009 sub-periods, respectively.

For the entire 1993-2009 sample period, we find the excess return on invested capital for a portfolio of top 5 pairs at 5.1% annualized (t-statistic = 4.07), a third lower than the result from the US market for roughly the same period 1989-2002 (Gatev, 2006, Table 8). For the top 20 portfolios, the excess returns for the Canadian and US market are roughly

Period	1993-2009		1993-2003		2004-200909	
TOP 5	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52
Mean	0.0509	0.0432	0.0488	0.0397	0.0700	0.0677
t statistics	4.0724	3.7970	2.7409	2.4869	3.0538	2.9727
Median	0.0504	0.0426	0.0635	0.0481	0.0644	0.0644
Standard deviation	0.1683	0.1531	0.1876	0.1683	0.1654	0.1643
Skewness	-0.1832	-0.2574	-0.3642	-0.5288	0.9598	1.0306
Kurtosis	1.5563	1.8327	1.2828	1.5549	1.5774	1.7426
Minimum	-0.5534	-0.5534	-0.5534	-0.5534	-0.2306	-0.2306
Maximum	0.5108	0.4792	0.5108	0.4792	0.5710	0.5710
Obs with ex<0	59	59	34	34	19	19
p value	0.0001	0.0002	0.0072	0.0144	0.0036	0.0045
95% Confidence	0.0263	0.0208	0.0135	0.0081	0.0240	0.0220
Interval	0.0756	0.0657	0.0841	0.0714	0.1161	0.1135

Period	1993-2009		1993-2003		2004-200909	
TOP 20	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52
Mean	0.0542	0.0469	0.0551	0.0473	0.0558	0.0487
t statistics	6.0575	5.6380	4.3948	4.0851	3.4722	3.2598
Median	0.0558	0.0463	0.0673	0.0476	0.0283	0.0254
Standard deviation	0.1205	0.1119	0.1320	0.1219	0.1158	0.1077
Skewness	-0.0781	-0.0056	-0.4178	-0.4388	0.5924	0.7443
Kurtosis	2.1653	2.8346	1.6865	2.1264	0.3638	1.2660
Minimum	-0.3983	-0.3983	-0.3983	-0.3983	-0.1921	-0.1921
Maximum	0.4617	0.4617	0.3726	0.3620	0.3829	0.3829
Obs with ex<0	50	50	28	28	17	17
p value	0.0000	0.0000	0.0000	0.0001	0.0011	0.0020
95% Confidence	0.0366	0.0305	0.0302	0.0243	0.0235	0.0187
Interval	0.0719	0.0633	0.0799	0.0702	0.0880	0.0786

Period	1993-2009		1993-2003		2004-200909	
TOP 101-120	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52
Mean	0.0298	0.0179	0.0317	0.0167	0.0289	0.0208
t statistics	2.4362	1.9267	2.0020	1.4289	1.2943	1.1672
Median	0.0256	0.0173	0.0214	0.0169	0.0130	0.0109
Standard deviation	0.1644	0.1251	0.1668	0.1231	0.1609	0.1282
Skewness	0.4178	0.3672	0.2149	0.1288	0.4580	0.3374
Kurtosis	0.5376	1.0978	-0.1631	0.3706	0.2840	0.4356
Minimum	-0.3610	-0.2932	-0.3610	-0.2611	-0.3206	-0.2913
Maximum	0.6336	0.4945	0.5181	0.4059	0.4134	0.3318
Obs with ex<0	82	82	49	49	24	24
p value	0.0158	0.0556	0.0477	0.1559	0.2014	0.2485
95% Confidence	0.0057	-0.0004	0.0003	-0.0065	-0.0159	-0.0150
Interval	0.0539	0.0363	0.0631	0.0398	0.0737	0.0565

Table 1: Annualized Mean Returns & Distribution Statistics

equal. Gatev (2006) reports declining pairs trading profits for the sub-period 1989-2002, down roughly a third of the mean return for the entire 1962-2002 sample which they attributed to the rise in hedge funds. Although our Canadian sample spans further into 2009, our results suggest that in the Canadian market pairs trading strategy did not exhibit a decline but rather an increase in profitability for the top 5 pairs portfolio. The return on invested capital for sub-period 2004-2009 is around 2% larger than the previous sub-period 1993-2003.

The excess return for a portfolio of the 20 best pairs at 5.42% (annualized, t-statistics = 6.06) is slightly higher than the top 5 portfolio by .32% with standard deviation for the top 20 pairs cut by a third. There are diversification benefits with a greater number of pairs in the portfolio. However, in the top 101-120 pairs portfolio, the return and standard deviation have both deteriorated. During the full sample period of 181 6-month returns, a portfolio of 5 pairs experienced 59 negative payoffs, compared to 50 for the portfolio of 20 pairs and 82 negative payoffs for the 101-120 pairs portfolio.

3.2 Pairs Trading by Sector

Tables II and III report the excess returns for the pairs portfolios wherein matched pairs belong to the same sector in contrast to the previous sample wherein the matching was based solely on minimum distance between pairs. Finding pairs that are highly correlated over time is the key to the success of this strategy and securities within same sector would be better correlated. Two sectors, Energy and Financials, are considered for this study. In addition, securities that have an average 6 month trading volume of at least 200,000 are also included in this analysis to give insight into whether thinly traded securities affect profitability.

Tables II and III summarizes the portfolio results for the top 5 pairs and top 20 pairs vertically. Across, the results shown from left to right are the full sample period followed by the sub-period statistics. On the last two columns of the table, we have the return statistics when thinly traded securities are included into the sample. The excess returns on invested

capital for the Energy and Financials sector are consistent within each sub-period and the entire sample period for each of the sectors.

With the inclusion of thinly traded securities in each sector for the sub-period 2004-200909, the excess return on invested capital is increased by approximately 1% for all three sectors while the standard deviation of excess returns have decreased substantially. An analysis for the entire period would be interesting but data is not easily available for many of the thinly traded securities in the Canadian market.

	FINANCIALS 500K						>200K	
Period	1993-2009		1993-2003		2004-200909		2004-200909	
TOP 5	Invested	Committed	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52		50
Mean	0.0554	0.0480	0.0548	0.0475	0.0592	0.0581	0.0639	0.0625
t statistics	5.5504	5.5745	3.9547	4.0460	3.3107	3.4093	5.0836	5.5771
Median	0.0457	0.0388	0.0457	0.0416	0.0473	0.0473	0.0678	0.0625
Standard deviation	0.1343	0.1160	0.1460	0.1238	0.1290	0.1229	0.0889	0.0792
Skewness	0.2027	0.2455	0.0746	-0.0656	0.5618	0.8063	-0.4304	0.0907
Kurtosis	1.0185	1.9764	0.8811	1.8632	0.1284	0.5440	0.7150	-0.1749
Minimum	-0.3861	-0.3861	-0.3861	-0.3861	-0.1574	-0.1574	-0.2066	-0.1031
Maximum	0.4551	0.4417	0.4551	0.4417	0.3790	0.3790	0.2579	0.2579
Obs with ex<0	64	64	41	41	17	17	10	10
p value	0.0000	0.0000	0.0001	0.0001	0.0017	0.0013	0.0000	0.0000
95% Confidence	0.0357	0.0310	0.0273	0.0243	0.0233	0.0239	0.0387	0.0400
Interval	0.0751	0.0651	0.0823	0.0708	0.0952	0.0923	0.0892	0.0850
			FINANCIALS 500K				**>200K**	
TOP 20	Invested	Committed	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52		50
Mean	0.0738	0.0464	0.0781	0.0465	0.0696	0.0532	0.0780	0.0726
t statistics	8.6492	7.6074	6.6416	5.8375	3.9833	3.7021	5.8670	5.7067
Median	0.0606	0.0390	0.0638	0.0390	0.0448	0.0324	0.0633	0.0600
Standard deviation	0.1148	0.0820	0.1238	0.0839	0.1260	0.1037	0.0941	0.0899
Skewness	0.3837	0.6336	0.1801	0.1906	0.7845	1.2033	1.3147	1.5812
Kurtosis	0.3236	2.0047	-0.2007	1.0935	1.1244	2.2810	3.3477	4.6672
Minimum	-0.2056	-0.2056	-0.2056	-0.2056	-0.1760	-0.1745	-0.0768	-0.0730
Maximum	0.3899	0.3436	0.3899	0.2953	0.4587	0.3844	0.4348	0.4348
Obs with ex<0	49	49	33	33	16	16	9	9
p value	0.0000	0.0000	0.0000	0.0000	0.0002	0.0005	0.0000	0.0000
95% Confidence	0.0570	0.0344	0.0548	0.0307	0.0345	0.0244	0.0513	0.0470
Interval	0.0907	0.0584	0.1014	0.0623	0.1047	0.0821	0.1048	0.0982

Table 2: Financial Sector Annualized Mean Returns

			ENERGY 500K				>200K	
Period	1993-2009		1993-2003		2004-200909		2004-200909	
TOP 5	Invested	Committed	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52		52
Mean	0.0565	0.0385	0.0523	0.0299	0.0526	0.0499	0.0681	0.0635
t statistics	3.8819	3.3081	2.7649	1.9651	1.7911	1.9952	2.8790	2.9079
Median	0.0599	0.0474	0.0532	0.0424	0.0222	0.0175	0.0686	0.0442
Standard deviation	0.1959	0.1566	0.1995	0.1603	0.2118	0.1805	0.1705	0.1574
Skewness	0.2112	-0.3930	-0.1897	-0.8081	1.4165	2.0916	0.6576	1.0522
Kurtosis	1.9305	2.3587	1.4280	3.0039	4.2275	7.7534	0.7229	1.5966
Minimum	-0.6562	-0.6562	-0.6562	-0.6562	-0.3138	-0.2430	-0.2622	-0.1744
Maximum	0.8376	0.4722	0.6381	0.4314	0.8637	0.8637	0.5609	0.5609
Obs with ex<0	70	70	45	45	21	21	17	17
p value	0.0001	0.0011	0.0067	0.0519	0.0792	0.0514	0.0058	0.0054
95% Confidence	0.0278	0.0155	0.0148	-0.0003	-0.0064	-0.0003	0.0206	0.0196
Interval	0.085255	0.061476	0.089876	0.06007	0.111564	0.100216	0.1156	0.1073
			ENERGY 500K				**>200K**	
Period	1993-2009		1993-2003		2004-200909		2004-200909	
TOP 20	Invested	Committed	Invested	Committed	Invested	Committed	Invested	Committed
Data Points		181		111		52		52
Mean	0.0339	0.0073	0.0394	0.0029	0.0169	0.0078	0.0874	0.0806
t statistics	2.6924	0.8568	2.1980	0.2471	0.9506	0.5914	5.6058	5.4479
Median	0.0348	0.0182	0.0416	0.0201	0.0253	0.0125	0.0861	0.0807
Standard deviation	0.1692	0.1138	0.1886	0.1247	0.1283	0.0953	0.1124	0.1066
Skewness	-0.2372	-1.0551	-0.2934	-1.2608	-0.3099	-0.2181	-0.1043	-0.0092
Kurtosis	0.9361	3.3103	0.7451	3.4305	-0.2101	0.4308	0.5561	0.5898
Minimum	-0.5478	-0.5255	-0.5478	-0.5255	-0.2605	-0.2239	-0.1931	-0.1910
Maximum	0.5917	0.3117	0.5917	0.3117	0.2938	0.2473	0.3485	0.3298
Obs with ex<0	68	68	44	44	19	19	11	11
p value	0.0078	0.3927	0.0300	0.8053	0.3463	0.5569	0.0000	0.0000
95% Confidence	0.0090	-0.0094	0.0039	-0.0205	-0.0188	-0.0187	0.0561	0.0509
Interval	0.0587	0.0239	0.0748	0.0264	0.0526	0.0343	0.1187	0.1102

Table 3: Energy Sector Annualized Mean Returns

3.3 Trading Statistics and Sample Composition

Table IV describes the trading statistics and composition of the pairs portfolio. The composition of the sample is not a full representation of the Canadian stock market due to unavailable historical data and low trading volume of certain securities. We note that the average percentage of forced trades is more than half which would indicate that the trading period may be too short in the Canadian market or that the chosen pairs are not close substitutes.

Trade Statistics	Top 5	Top 20
Average number of pairs traded per 6-month period	4.27	16.43
MAX number of round trips per pair	5	5
MAX number of round trips per pair without forced close	4	4
Average number of round trips per pair	2.05	2.72
Average Percentage of forced trades	58%	60%
Composition by Sector of Sample		
Materials	10	
Energy	8	
Financials	8	
Consumer Discretionary	2	
Health Care	2	
Industrial	3	
Telecom	2	
Utilities	1	
	36	

Table 4 : Trade Statistics and Sample Composition

3.4 Risk Characteristics of Pairs Trading Strategies

To study if the observed portfolio returns can be explained by risk factors, we regress the pairs trading portfolio returns against several risk factors. We include the three Fama and French (1993) factors (SMB, HML, and excess U.S. market returns) and a fourth Momentum factor. The results are presented in Table V for the different portfolios and holding periods.

In each case, we estimate the following four-factor regression model:

$$r_t^{port} = \alpha + \beta_1 \left(r_t^{mkt} - r_t^f \right) + \beta_2 \left(SMB_t \right) + \beta_3 \left(HML_t \right) + \beta_4 \left(MOM_t \right) + \varepsilon_{p,t}$$

where $r_{port,t}$ represents the 6 month trading period return of the pairs-trading portfolio, and $r_{f,t}$ is the return of the one- month Treasury Bill. The four independent variables are the excess return on the U.S. market portfolio ($r_{m,t} - r_{f,t}$), the difference between the returns of value-weighted portfolios of small and big firm stocks (SMB_t), the difference in returns of value-weighted portfolios of high and low book-to-market stocks (HML_t), and the difference in average returns on the two high prior return and low prior return portfolios (MOM_t). The monthly returns for the four factors are compounded for each of the 6 months within the trading period to calibrate correctly the independent factors against 6 month excess return in the sample distribution.

Table V summarizes the portfolio performance for the entire sample period, in particular, the sub-period 2004-2009 for all sectors, and separately for the Financial and Energy sectors. In the entire sample period for all sectors, the returns load significantly on the market, SMB and MOM factors with an insignificant alpha. In the sub-period 2004-2009 where we find excess returns of 7% for the entire sample, the alpha is highly significant and the returns load significantly on the market and SMB but the magnitudes are economically insignificant. However, for the two sectors studied in this paper, the return on the Financial and Energy sector in the recent 2004-2009 period have significant beta coefficients for the market and the momentum factors. The intercept or alpha is also significant. Based on this numbers, we argue that the pairs trading strategy's excess return for the sectors during 2004-2009 sub-period comes in part from bearing systematic risk not eliminated through diversification.

On the other hand, using the Fama-French 3-Factor model augmented with the momentum factor to determine the risk factors in the pairs trading strategy, faces the joint hypothesis problem between the asset pricing model and market inefficiencies (Roll, 1977). One obvious factor that is not considered given the economic turmoil of 2008 is market volatility and liquidity risks. Greater arbitrage opportunities during down market could be one explanation for the increase in profitability in the recent 2004-2009 sub-period contrary to the diminishing profitability attributed to hedge fund activities in the Gatev, et. al study between Pre-1989 and Post 1989 periods. The existence of a dormant risk factor discussed

in Gatev, et al (2006) attest to other risk factors not captured by the Fama-French factors in the pairs trading strategy.

	1993-2009		2004-2009					
	All Sectors		All Sectors		Financial		Energy	
Portfolio Performance								
Mean excess return	0.0509		0.0700		0.0639		0.0681	
Standard deviation	0.1683		0.1654		0.0889		0.1705	
Sharpe Ratio	0.30		0.42		0.72		0.40	
Serial Correlation								
Risk Factors		*t-stat*		*t-stat*		*t-stat*		*t-stat*
Intercept	0.095	*0.6418*	1.4653	*4.8622*	0.2992	*2.0424*	0.4212	*2.6589*
Market	-11.02	*-2.184*	0.0000	*-4.7877*	-13.925	*-2.7871*	-12.406	*-2.2946*
SMB	12.42	*1.748*	-0.7903	*-6.1375*	-10.609	*-0.8576*	8.405	*0.6305*
HML	0.865	*0.142*	-0.5037	*-1.3594*	11.848	*1.3503*	-16.226	*-1.733*
MOM	-8.984	*-1.951*	0.1362	*0.5076*	-13.669	*-3.4574*	-18.006	*-4.212*
R2		*0.06*		*0.60*		*0.23*		*0.39*

Table 5: Risk Factor Coefficients

4 CONCLUSION

This paper examines the simple convergence trading rule that has been found to be profitable for a long period of time in the US market. In our sample period for the Canadian market, we find profitability at a lesser magnitude in prior years then increasing in the recent years. Based on the Fama-French factor model, this increased profitability has exposure to market and momentum factors. Current trend in Canada indicate that pairs trading continues to be lucrative investment strategy today.

Related future research in pairs trading in the Canadian market is important to address some weakness of this research. The framework used in this study did not consider transaction costs and liquidity risk of the strategy, which affects the realizable returns. In addition, given the limited data, the chosen pairs may not be the optimal and closest substitutes of each other. The results of this positive performance can only be assessed given these constraints.

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