

STATISTICAL ARBITRAGE AND FX EXPOSURE WITH SOUTH AMERICAN ADRs LISTED ON THE NYSE

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Abstract: An American Depositary Receipt (ADR) represents ownership in the shares of a foreign company trading in US financial markets. We test a pair trading rule based on the mean reversion assumption for six South American stocks and their ADR counterparts on the NYSE. In our opinion, such a strategy should separate the spread risk from the currency risk.

This paper aims to challenge the positive results found in similar settings. The main achievement is to show that isolating FX exposure turns such strategies that were presented as profitable to unprofitable and abnormal returns are just due to an appreciation in the home currencies versus the USD. Hence the results in some of literature should be revised.

Keywords: ADR, FX exposure, Statistical Arbitrage, Trading Strategy.

JEL Classification: C0, G1, G15

1 Introduction

Risk management is still a non-friendly area for many managers in the financial industry; for instance difficulties accrued for managing long/short equities associated with hedge funds. This includes estimating and hedging the risks that portfolios are exposed to. Many funds went out of business by choosing the strategies where the risk exposures were neglected or calculated incorrectly.

Strategies such as L/S are rooted in the pair trading which was developed in the late 1980s by quantitative analysts and pioneered by Gerald Bamberger at Morgan Stanley. The strategy focuses on the highly correlated financial instrument. The goal is to make a profit from the price reverting back to the mean trend as the spread between the two converges. According to Lo and MacKinlay (1990), “A *portfolio strategy that sells 'winners' and buys 'losers' can produce positive expected returns if returns on some stocks systematically lead or lag those of others.*”

Pair trading known as “statistical arbitrage” is used recently by hedge funds and investment banks. The strategy is based on the classic hedging technique which is an old method in portfolio management. Despite the simplicity of the concept behind the strategy, in practice this can be among the complex types of trading. For instance Gatev, Goetzmann and Rouwenhorst (1999) represent the annualized excess returns of 11% for using such a strategy. Taking the transaction costs into account, they still find the pair trading strategy to generate significant excess returns.

The strategy is mentioned in some papers as market neutral investing. Lin, McCrae and Gulati, (2006) and Nath (2003) refer to the pair trading as “riskless”. They conclude that the riskless temperament of the pair trading strategy originates from simultaneous long/short opening of market positions.

Looking back to August 2007 and in contrary to authors above, we observe significant losses in hedge funds within few days. *“The losses were the short-term side effect of a sudden liquidation by a multi-strategy fund or proprietary-trading desk. In fact, most of the hardest-hit funds were employing long/short equity market-neutral strategies sometimes called statistical arbitrage; strategies that, by construction, did not have significant beta exposure, and which were supposed to be immune to most market gyrations”* Khandani and Lo (2008).

Evidence shows that there are mixed opinions about the profitability of the statistical arbitrage trading strategies and perspective of different types of risks and their involvements in such scenarios. In our paper we examine a simple trading rule in pairs trading in ADRs of South American shares. An American Depositary Receipt (ADR) represents ownership in the shares of a foreign company trading in US financial markets. The stocks of many non-US companies trade on US exchange through the use of ADRs. ADRs enable US investors to buy shares in foreign companies without undertaking cross-border transactions. ADRs carry prices in US dollars, pay dividends in US dollars, and can be traded like the shares of US-based companies.

We pursue a trading rule based on the notion of mean reversion of the ratio of an ADR and its corresponding underlying. The main contribution of this paper is the first check whether the abnormal returns described in similar settings can be sustained if we isolate the FX exposure. In our opinion, a pair trading strategy must separate the two legs of risk exposure, the spread risk and the currency risk. Despite their ad-hoc method of a relatively long holding period of 12 months, Hong and Susmel neglect the FX risk and it might well be that the abnormal returns are just due to an appreciation in the home currencies versus the USD. Although our strategy is similar to their pair trading strategy, we have come up with a more clean definition of when we enter and close a position and contrary to Hong and Susmel (2003), we do not use the difference between the USD price of a share and its corresponding ADR as the variable to observe but their ratio to correct for size effects. The main finding of this paper is that once the FX exposure is isolated out of the trading rule, pair trading in South American stocks with the corresponding ADRs is no longer profitable.

2 The data set

All data was obtained from DataStream. We used daily data from January 02, 2003 to April 22, 2009 for the following six South American stocks and their corresponding ADRs listed on the NYSE: Petrobras (BR), Ultrapar (BR), Metrogas (AR), Vitro (MX), TSPA (AR) and Enersis (CL). We then multiplied the stock prices on every day with the corresponding exchange rate to get the USD price of the stock. Then, we calculated the ratio of the USD price of the stock and the price of the ADR to get our main variable for the analysis. This variable is all we are looking at. The next section describes the process of trade generation based on this variable in detail.

3 The model

In all trades we will simultaneously go long in the underlying, i.e. the stocks listed on the home stock exchange in South America, and we go short on the ADR which is listed in New York. This limits the potential trades, however, there might be short sale restrictions in South America and we decided to make all trades as replicable as possible and ignored trading signals that would result in a short position in the original stock.

We calculated the ratio $R_t = \frac{(p_{Stock})_t}{(p_{ADR})_t} \cdot \frac{\#USD}{1 \text{ unit of foreign currency}}$ for day t where p_{Stock} is the price of the stock denominated in its home currency and p_{ADR} is the price of the ADR denominated in USD on the NYSE. That ratio is calculated for all trading days and is the source from which trading signals are generated. For each data point of the ratio we calculate the 20-day simple moving average and the 20-day standard deviation. A trading signal is generated when the ratio R falls below the 20-day moving average of the previous day minus three standard deviations as calculated from the previous day: let μ_t be the 20-day simple moving average and σ_t the 20-day standard deviation. On the next day we observe R_{t+1} and the trading signal is generated if $R_{t+1} < \mu_t - 3 \cdot \sigma_t$. Then, in the closing auction, for each 1 ADR that we sell, we buy the following number of shares on the home exchange at the same time:

$$\frac{(p_{ADR})_t}{(p_{Stock})_t \cdot \frac{\#USD}{1 \text{ unit of foreign currency}}} \quad (1)$$

In doing so, we utilize the total proceeds from our short sale of the ADR for the purchase of the stocks. However, we assume conservatively that for a short sale 50% initial margin of the notional sold is necessary.

Closing of trades: We close a trade in the closing auction of day t if at day $t - 1$ we observe that $R_t > \mu_t + 3 \cdot \sigma_t$

Rationale for the strategy: we would like to test whether abnormal changes in the pricing relationship of cointegrated securities from the mean can be exploited when the relationship reverts again to the mean. We remark that this methodology is more consistent than the ad-hoc rules found in Hong and Susmel (2003) which are based on the difference of the price of the ADR and the stock. In a frictionless economy the ratio R_t should be equal to 1 and any deviation from 1 should last only for a short time.

3.1 Risk exposures

We briefly characterize our strategy by discussing the most important risk parameters:

1. **FX risk.** This is the critical point in any pair trading strategy that includes securities denominated in a foreign currency. Most papers have neglected to separate this risk. We will analyze both the case with an imperfect static FX hedge and the non-hedged

case. It will turn out that recent studies about the profitability of pair trading in ADRs cannot be sustained when stripping the FX gains off. Details about the hedging methodology will be presented in the next section about money management.

2. **Beta risk.** Our strategy is beta neutral and does not exhibit any directional view. The general idea behind this simple trading rule is that a multiple standard deviation move in the ratio R on a single day reflects an abnormal big movement away from the short-term norm and should be corrected.
3. **Time zone risk.** This risk is eliminated since the NYSE and the South American exchanges allow simultaneous execution of trades.
4. **Liquidity risk.** Since we deliberately chose major well-known South American stocks, we have minimized this risk to a large extent: the volumes on the home exchanges are well above their national averages and do not pose any threat to the replaceability of the strategy. The same is true for most of the ADRs chosen with average daily volumes on the NYSE in tens or hundreds of thousand units. Merely Metrogas ADRs might be subject to liquidity constraints with an average daily volume of just 5000.

4 Money management and FX hedging methodology

The dynamics of financial markets have been changed rapidly. There are many investment alternatives compared to local trading strategies. Being open to an emerging market and ability to trade in non-US corporations is an opening door for investors. There is no doubt about the growth in the non-US stock market for the past decade. Developing countries and markets like the Indian stock market and the Asian stock market had remarkable returns in comparison.

According to Citigroup Inc. (2011), *“The total US investment in non-US equities including ADRs and non-US shares has increased steadily over the last 19 years, rising from \$279 to \$4.4 billion in 1991, 4.4 trillion in 2010. Additionally, overall ADR trading volumes increased to 147.4 billion shares in 2010, growing at a compound annual growth rate of 19% since 2006, reinforcing the long-term trend of constant growth in cross-border trading. Specifically, capital raised in the form of ADRs by non-US companies reached \$20.7 billion in 2010, a 26% increase over 2009.”*

This growth will open more doors for risk factors and mainly the FX risks for traders in global market. One of the main issues in modern portfolio management and managing money is how to invest globally. Moving back to the risk exposures, there are different applications of the statistical arbitrage strategy. Klaus Grobys (2012) developed the Statistical arbitrage strategies based on cointegration-optimal weight allocations. He claims that usage of such a method will generate significant abnormal annual returns between 2.44% and 11.96%. He phrases in his paper: *“This method will give the chance to the investors to anticipate advantageous developments of foreign economies, respectively, foreign stock markets in future periods. As a result of that the statistical arbitrage corresponds to the stationary linear trend which behaves relatively stable over time, depending on the enhancement factors.”*

Some authors believe in more sophisticated statistical arbitrage strategies. For instance, Alexander and Dimitriu (2005) used artificial indices in their paper and they constructed

portfolios using these indices where they traded on their spread. Counterpart to their paper, Klaus Grobys (2010) used the statistical model based on the artificial stock index. According to his paper, the advantage of this method is that the estimated portfolio shows higher return and lower volatility in comparison to the benchmark.

An alternative view is presented by James Velessaris (2010) who believes in diversification of the strategies. In his paper, he combines mean reversion and momentum investment strategies to construct a diversified statistical. He concludes that this strategy rebalances the exposures towards the market fluctuations and as a result it will work well in up and down market.

As we observe, the pair trading is an active trading strategy. Pair traders always seek for stocks whose prices move together. In this methodology we will examine the risk-return characteristics of the method and to take the first step towards the strategy, we choose the South American stocks and their corresponding ADRs listed on the NYSE.

Next, we take a long-short position by going long on the stocks listed on the home stock exchange in South America and going short on the ADR which is listed in New York for our trading strategy. We select the trading rule based on the total capital of 100 units. We then divide our total capital into 6 equal sub-portfolios with a starting value of 16.66. As a next step we trade in each security independently with one of these sub-portfolios. It means that the total risk of each trade is limited to losing 16.66. Our total capital at any time is just the sum of all sub-portfolios.

Theoretically, the capital needed to initiate the positions in the stock and the ADR is zero because our strategy is dollar neutral. However, investors need a margin account to sell short securities and we assume that 50% of the notional sold short is needed in advance. It means that for every unit we sell short we must have 0.5 in equity. Besides this constraint, however, we assume that we can use the proceeds of the short sale almost instantaneously to buy the stock on the home exchange. This assumption is quite realistic for professional investors.

We pursue an imperfect because static hedge of our long exposure to the South American currency versus the USD: for every 1 USD equivalent for which we buy South American stocks we sell 1 USD equivalent of the South American currency. It means for small changes in the price of the foreign currency denominated stock we offset movements of that foreign currency with our FX position. The hedge is imperfect because we do not adjust it for movements in the stock price.

We assume a leverage of 2 in our FX hedging portfolio which results from the fact that we use 50% of our cash balance in any sub-portfolio for the stock and ADR portfolio and commit the remaining 50% for the hedge. Since we assume 50% margin for the short sale we have to use a leverage of 2 to offset the currency risk. A leverage of 2 is not only realistic but quite conservative. Nevertheless, increasing the leverage of the FX portfolio, i.e. committing less capital for the FX trade that could be utilized to increase the position in the stock-ADR spread, will surely not increase the profitability of the strategy as will be briefly illustrated in the next section.

5 Results

5.1 FX exposure stripped off

Figure 2 shows the summary statistics for the hedged trades calculated for daily values of the cash balance. As expected we observe a disappointing performance, even before considering transaction costs which are twofold at every trade since we have 2 legs in each trade. Testing the monthly returns for significance, i.e. making the null hypothesis that $\mu_t = 0$, we obtain a t-value of 0.8341 which means in this case we cannot reject the hypothesis even at a 0.1 level.

Looking at the histogram in Figure 1 we observe a positive skewness which is calculated in Figure 2 as 0.64. The results are hardly of any value to an investor and the summary of the strategy presented in Figure 3 makes this point more than clear. The Sharpe ratio yields a negative value and we do not state it since negative Sharpe ratios have no meaningful interpretation except that the strategy is not worth considering for implementation.

Figure 4 illustrates the evolution of the cash balance, starting initially with 100 units of account. The path could resemble a random walk and no drift can be determined, even when subdividing into more intertemporal periods. A subdivision into three periods of two years yields similar results. There is no explicit return clustering as we can see from Figure 5. All these results point out that the general notion of profitable pair trading as outlined in Hong and Susmel(2003) should be added with a Caveat at the very least. This is because our strategy already reduced one major risk which arises in the Asian market, namely different time zones.

5.2 Unhedged strategy: FX exposure added to the trading book

In this section we report the results for the above presented strategy for the case we do not take any means to hedge the FX exposure, i.e. we add this risk to our spread exposure. From a rational point of view such strategies do not make sense because any result is likely to be a random outcome of two risk factors and any positive result is not due to a superior trading strategy but mere luck.

Nevertheless, we include the statistics for this "strategy" because in Hong and Susmel (2003), FX exposure is not hedged and pair trading in ADRs is presented as a profitable strategy. Indeed, taking the naïve view of their paper we will indeed end up with significantly positive results, but not even that spectacular as their 33% return. Figure 6 reports the statistics and performance measures. We remark that although the Sharpe ratio is not good, the Sortino ratio – which does not penalize for upside volatility – is excellent. That is not due to the magnitude of the abnormal returns but to the low downside volatility of only 5.9%.

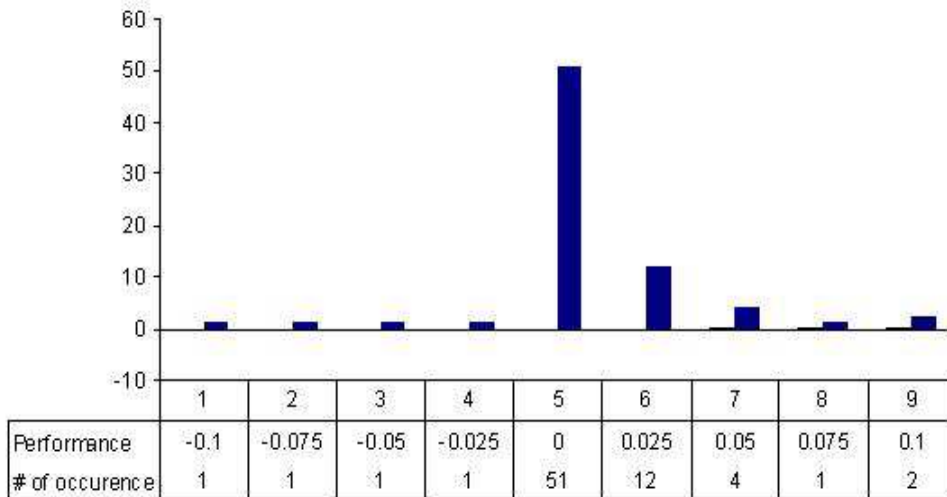
Figure 7 illustrates the evolution of the cash balance. We observe a very strong performance between October 2006 and January 2008. As outlined in the introduction this is most likely due to appreciating South American currencies. We tested this and built a customized currency basket, calculated from investing 1 USD in BRL, ARS, MXN, COP on January 01, 2003 weighted according to the number of stocks denominated in that currency and indexed to 100 at the start. Clearly, the performance of the trading rule is symmetric to the value of 1 USD

invested in the basket which once more illustrates that the return in the unhedged cases is not due to an intelligent trading algorithm, but luck in the form of FX exposure.

5.3 Graphs and Tables of FX hedged Vs. FX unhedged trading strategy

The first graph (Fig. 1) shows the distribution of monthly returns of the FX hedged trading strategy. By looking at the histogram, we observe a positive skewness.

Fig. 1 Distribution of monthly returns of the FX hedged trading strategy



Source: Authors

In the follow up to our histogram, we are providing the summary statistics for the hedged trades calculated for daily values of the cash balance (Fig. 2). As we expected, we are not observing satisfactory performances, however the positive skewness is preferred from a trading point of view.

Fig. 2 Summary statistics of FX hedged strategy

Summary statistics monthly returns	
mean	0.0027321
std	0.0279855
annualized vol	0.0969446
skewness	0.6427286
Kurtosis	7.8533495

Source: Authors' calculation

After reviewing the basic statistics, we will go more into details of our analysis by evaluating a descriptive statistics for the FX hedged trading strategy. The results shown in the table below (Fig. 3) make it clear that such a strategy is hardly of any value to an investor. The negative sharp ratio is another sign that the strategy is not worth implementing.

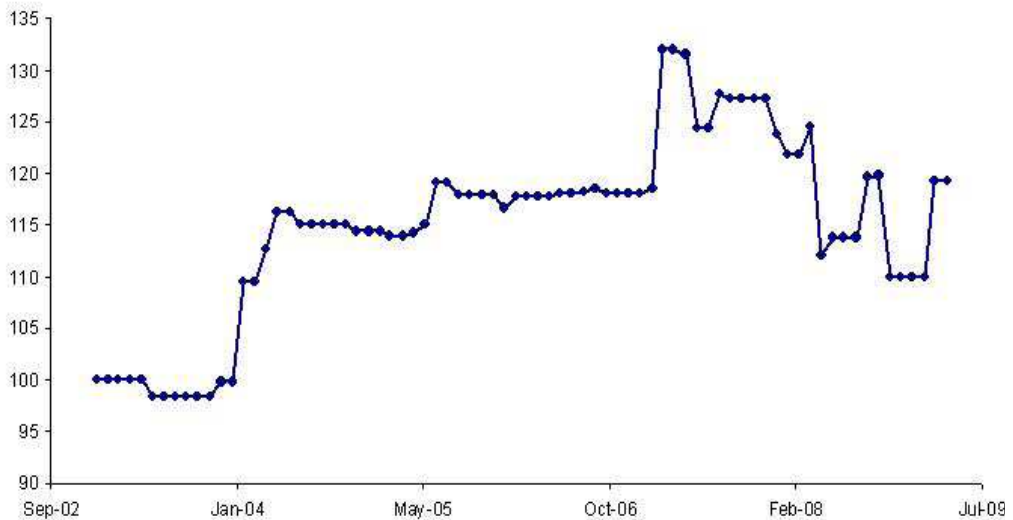
**Fig. 3 Descriptive statistics for FX hedged trading strategy
January 02, 2003 - April 22, 2009**

Summary 2003-2009 all stocks FX hedged	
portfolio value (1.1.2003 set 100)	117.6357478
all-time high	131.9590408
annualized performance	2.51%
annualized vol	10.20%
Sharpe ratio	Negative
maximum drawdown	19.55%
Calmar ratio	0.128707409
Sortino ratio	6.806016561
Annualized downside deviation	5.74%
daily value-at risk (99%)	-12.32%
number of trading days	1647
number of trades	61
number of winning trades	32
number of losing trades	29
average holding period in trading days	59.73770492

Source: Authors' calculation

The next graph (Fig. 4) illustrates the evolvement of the cash balance considering the FX hedge effect in our strategy. We start with 100 units of account. The path could resemble a random walk and no drift can be determined, even when subdividing into more intertemporal periods.

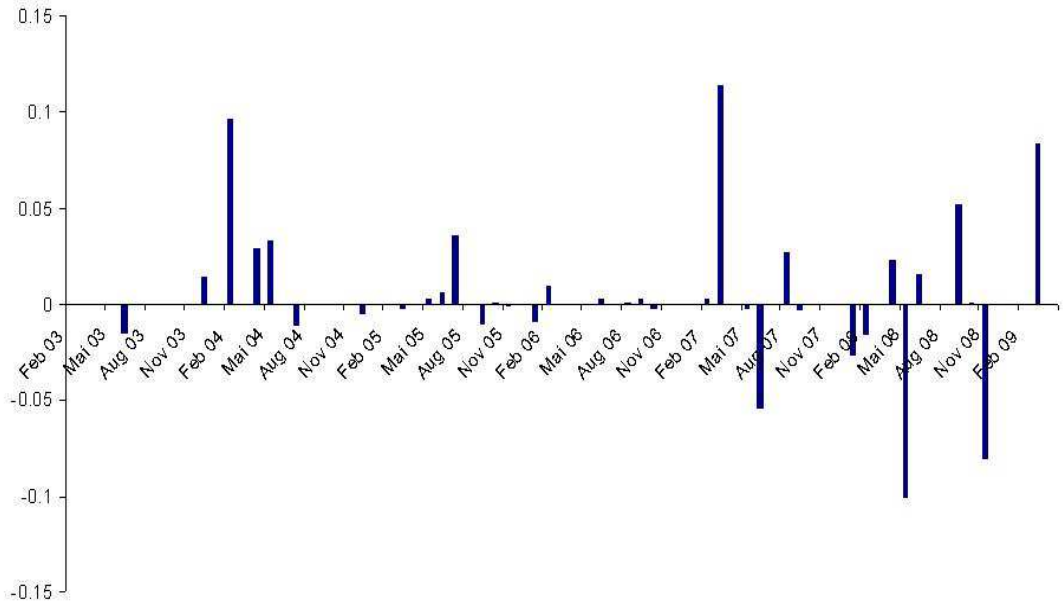
**Fig. 4 Development of cash balance when employing the trading strategy
with FX hedge**



Source: Authors

The graph in Fig. 5 presents the monthly returns of the FX hedged trading strategy. There is no explicit return clustering as we can see from this figure.

Fig. 5 Monthly returns of the FX hedged trading strategy



Source: Authors

The next table (Fig. 6) is the statistic and performance measures of 2003–2009 for all the stocks in the case of FX exposure being added to the trading strategy. We can observe some remarkable results in this table, mainly Sharp ratio and Sortino ratio.

Fig. 6 The Sortino ratio and low downside vol are remarkable

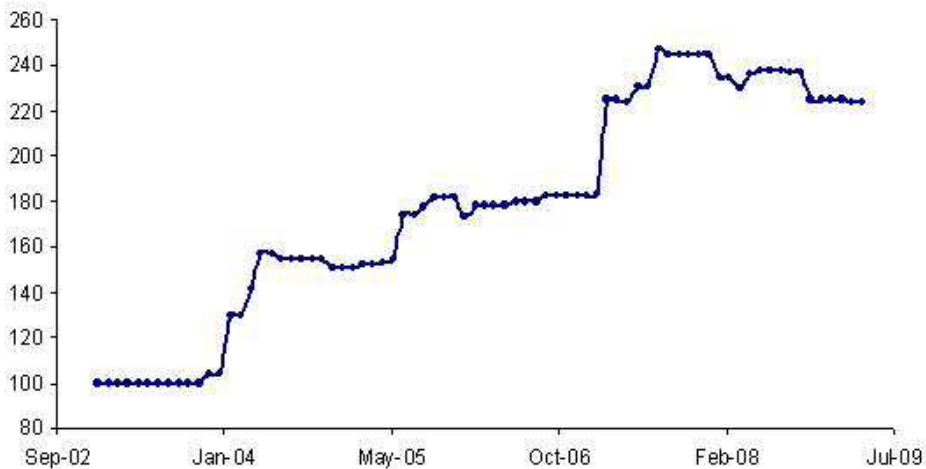
Summary 2003-2009 all stocks FX exposure not stripped off	
portfolio value (1.1.2003 set 100)	196.25
all-time high	247.27
annualized performance	0.1086
annualized vol	0.1539
Sharpe ratio	0.545095499
maximum drawdown	0.206335768
Calmar ratio	0.526660407
Sortino ratio	11.81205303
Annualized downside deviation	0.059108014
average 30 day vol	0.0661
maximum 30 day vol	0.7336
average 90 day vol	0.0981
maximum 90 day vol	0.4713
maximum drawdown	0.0735
daily value-at risk (99%)	-0.12316191
number of trading days	1647

number of trades	45
number of winning trades	26
number of losing trades	19
maximum winning trade	1.5699
maximum losing trade	0.179
average holding period in trading days	80.98

Source: Authors' calculation

The next graph (Fig. 7) focuses on the development of our cash balance when we have the FX unhedged strategy. As we see in the graph, the performance between October 2006 and January 2008 is strong. The reason for this performance is most likely the appreciation of South American currencies.

Fig. 7 Development of cash balance when employing the trading strategy without FX hedge



Source: Authors

The following table (Fig. 8) shows the summary statistics of the unhedged strategy in comparison to Fig. 2. We can observe how the values are changed from one strategy to another.

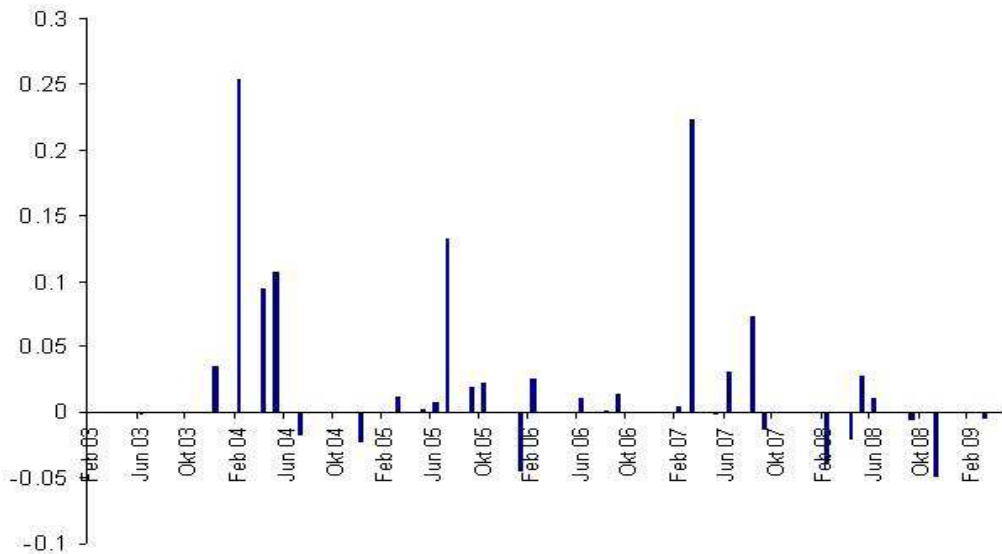
Fig. 8 Summary statistics of FX unhedged strategy

Mean	0.011751092
Std	0.046389202
annualized vol	0.160696908
skewness	3.640614206
kurtosis	15.19126398
t value	2.16432639

Source: Authors' calculation

Fig. 9 presents the monthly returns of the unhedged strategy and in comparison to Fig. 5 we observe obvious jumps and changes in our monthly returns.

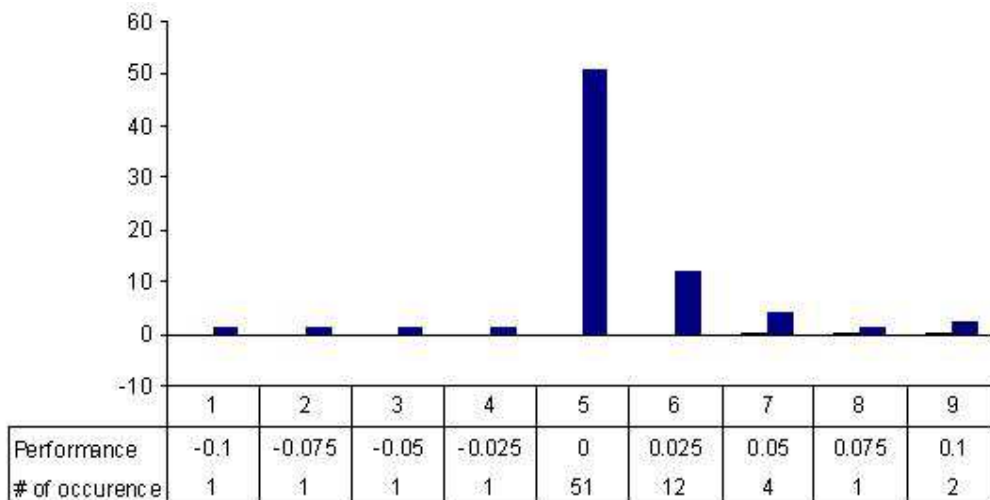
Fig. 9 Monthly returns of the unhedged strategy



Source: Authors

The histogram below is similar to Fig. 1 and shows the distribution of monthly returns in a different trading strategy setting of the data (Fig. 10).

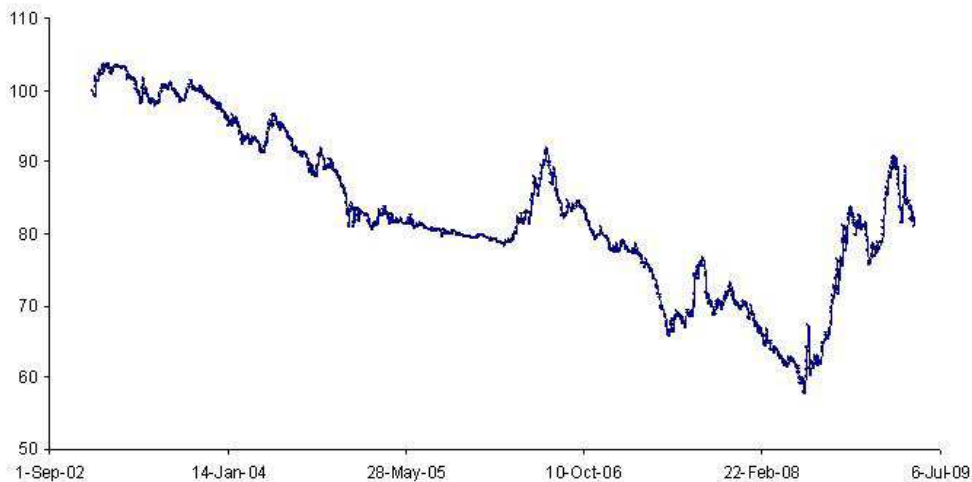
Fig. 10 Distribution of monthly returns of the unhedged trading strategy



Source: Authors

The last figure (Fig. 11) shows the development of 100 USD invested in a basket of BRL, ARS, MXN, COP weighted 2/6, 2/6, 1/6, 1/6, respectively, whose nominators are equal to the number of stocks traded that are denominated in that currency.

Fig. 11 Illustration of the currency effect the trades were exposed to



Source: Authors

6 Conclusion

Being inspired by Hong and Susmel (2003) at first and keen to even extend their strategy with a more consistent model we finally found that an old analogy of risk-return spectrum "The more return sought, the more risk must be undertaken" is still the underlying mentality of investors. Having that in mind, the abnormal return in any trading strategy should be a good signal of the other side of the pole of the spectrum which is the riskiness of the strategy. As a result, success in such a complex market will be achieved only by calculated risk. In addition to the complexity of the market, recent events and the financial crises are making many of us doubt our understanding of risk.

There is no doubt about the attractiveness of ADRs for investors. By investing in ADRs, raising money in different capital markets will be available for international companies, global demand for stocks can increase the local price of the shares and foreign investors can diversify their investments but this attractiveness should not lead investors to concentrate on the positive side of the trade only.

The coin always has two sides; **Risk** and **Return**.

Let us dwell for a moment upon the quote from *The Wall Street Journal* of April 10, 2008: "**If you thought getting into a hedge fund was tough, try getting out of one**". By referring to this quote, we would like to shift the attention to the liquidity risk. Investors should be cautious

about this risk. As we chose the well-known South American stocks, we have minimized the liquidity risk to a large extent.

In addition to liquidity risk, investors should be aware of the short selling restrictions. Some markets have short selling restrictions which will limit the spread to converge. Thereby, in all trades we simultaneously went long in the underlying in stocks listed on the home stock exchange in South America and we went short on the ADR which was listed in New York to overcome any potential restrictions.

The time zone risk was neglected in our strategy as we were dealing with the South American ADRs, however this fact should be considered as one of the major risks involved in pair trading. For instance, if the ADR is in the Asian market, the market is not open yet while the US market is open. This can shrink the trading session overlap and as a result the pairs cannot occur.

We would like to remark the cost of carry here as well. We have not considered the cost of carry in our analysis, i.e. the performance in the FX positions needs to be corrected for interest earned or paid in every trade. Since in general the rates in Mexico, Argentina, Colombia and Brazil were higher than in the United States, we would book additional losses on all FX trades.

Last but not least, there is the transaction cost which should not be hidden from the eye of investors. We neglected the transaction cost in our analysis but in reality investors should be conscious of this cost. They have to make sure that the profit of the spread will not be lost in the transaction cost.

In general, there are various types of risks involved in any trading strategy, each with their own positions on the overall risk-return spectrum. As we observed in our investigations into the statistical arbitrage strategy, the abnormal returns in such a scenario were the result of involving the FX exposure in the trading rule in a wrong direction.

Identifying risk factors is only the first step towards reality. Their separation is another challenge towards the realistic results. Even by looking at the risk factors in such a simple strategy we could observe how easily we could be misled and end up with biased returns.

This paper may be an opening to a different perspective of observing risk and risk factors and their involvement in the right direction in more complex strategies. We would like to end our investigation in this paper with the famous quote by Jacques Hadamard: ***"The shortest path between two truths in the real domain passes through the complex domain."***

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