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Arbitrage opportunities in the depositary receipts market: Myth or reality?

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Abstract

We analyze the price discrepancy between American depositary receipts (ADRs) and their corresponding underlying shares using a high frequency data set of French and American stocks. Albeit infrequent, it is shown that large deviations from the law of one price are present in the data and an arbitrage trading rule reveals that profits could have been made on these large disequilibria. We thus classify these markets as disintegrated and not fully efficient. An estimate of the minimum size necessary to make a price discrepancy profitable is provided and we propose this variable as a proxy for measuring the degree of efficiency displayed by the markets involved.

JEL classification: F-36

Keywords: Depositary receipts (ADR); Market efficiency; Arbitrage

1. Introduction

The continuous expansion of depositary receipt (DR) programs has attracted the attention of academics in numerous areas, producing research broadly aimed at establishing the nature of cross-listed stocks, in relation to their underlying securities in the home market,

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the timing and market reaction to their appearance and the process of international information diffusion affecting such international stock markets. Understanding the nature of DR programs implies establishing how different they are from their underlying shares and whether they trade in markets that are integrated and efficient.

Aside from the fact that both versions of a cross-listed stock are traded in the currency of their corresponding market, DRs and their underlying shares are essentially the same security, since they represent identical future streams of payments. Under complete market integration where both dual securities are determined by the same pricing factors, as well as a common information set they should be priced identically. Even in the absence of complete integration, active arbitrageurs should take advantage of the possibility of translating American depositary receipts (ADRs, as they are most intensively traded in US markets) into underlying shares and act on market disequilibria when the price of an ADR differs from that of its underlying share by more than transaction costs, thus naturally bringing prices back in line with each other.

Conflicting opinions on whether or not markets for cross-listed stocks are indeed fully efficient can be found among both financial specialists and academics. As a general rule, people who are dogmatic believers of the efficient markets hypothesis cannot conceive of the possibility that there are forgone arbitrage opportunities in a developed and highly traded market. On the other extreme, the 'word on the street' is that arbitrage opportunities are relatively frequent in this setting. The fundamental question to be addressed in this article is thus whether or not arbitrage opportunities exist in the ADR market.

The arbitrage operations at hand are not completely devoid of risk; foreign exchange risk, stale quotes, the inherent delay of the ADR subscription/cancellation order and lack of accurate, instantaneously flowing information, may prevent this market from ever being a perfect haven for risk-averse arbitrageurs. Though the fungibility between cross-listed stocks in unrestricted markets may be limited, it is nonetheless definitively real. Consequently, when the prices of two comparable stocks are significantly different, the mispricing will become a marginally attractive deal for the arbitrageur potentially with the smallest trading costs in the market who is willing to take a minimal risk.

Mainly using daily closing prices, seminal research in this area established that the law of one price cannot be rejected; cross-listed securities are indeed one security.[1] As these works focus on the global behavior of dual stocks' prices, the conclusions to be drawn from the previous consensus, however, are not clear. Even within the paradigm of continuous price parity, because stock markets have different trading hours, it is evident that two closing prices must not be equal and a price deviation could not be distinguished from a simple price change in the time between the closing of the two markets (Karolyi and Stultz, 1996). Moreover, if markets are relatively efficient, we expect large price discrepancies to be short-lived and thus mostly invisible to an observer with daily sampling.

Obviously, this controversy can only be resolved in a higher frequency setting and the two existing studies that use intradaily data have come to contradictory results. First, Miller and Morey (1996) examine data for one British security cross-listed in the US,[2] and find that the price difference in the two markets is small throughout their 2-month sample. Contrary

[1] Studies with daily data include Rosenthal (1983), Kato et al. (1992) and Park and Tavakkol (1994).

[2] They studied Glaxo–Wellcome, one of the most heavily traded British ADRs.

to Miller and Morey's findings of efficiency, Kaul and Mehrotra (2000) study cross-listed Canadian stocks which are directly traded in American markets and conclude that infrequent arbitrage opportunities do exist here, particularly with stock pairs that present a combination of relatively low spreads and low trading volume. An arbitrage operation in this market, however, is different from one involving ADRs, where one needs to 'translate' the ADR to complete the operation, thus involving different risks and transaction costs.

Establishing the existence of profitable arbitrage opportunities addresses two important questions about cross-listed securities: Are they traded in integrated markets and are these markets efficient? The answer to the first question may be found in research by Kleidon and Werner (1996), who exposed a lack of complete integration. To come to their conclusions, the authors compared cross-listed British stocks to non-cross-listed ones to reveal that known, U-shaped, intradaily volatility patterns apply indistinctively, implying that new information, a different investor's attitude, or different investors altogether exist on the American side of the market (see also Lowengrub and Melvin, 2002).

In this work, we provide conclusive evidence that arbitrage opportunities do exist in depositary receipt markets, even for the most heavily traded stocks. With the use of intradaily data sets from the French Stock Exchange as well as the New York Stock Exchange and intradaily French franc/US$ exchange rates, we analyze the price discrepancies of both French ADRs and American companies cross-listed in France. The price comparison is done on the $1\frac{1}{2}$ h overlap of the trading day, when both involved markets are open. It is shown that deviations in the short run are commonplace and significant, but that they are generally not large enough to make arbitrage operations profitable. Albeit infrequent, discrepancies outside a hypothesized no-arbitrage band (defined as the minimum size for a discrepancy to represent a profitable arbitrage opportunity) appear in the data. A thorough study of the data displays how often we observe divergences outside this no-arbitrage band and a corresponding exercise shows that a simple trading rule could have provided significant profits for hypothetical arbitrage operations.

The aim of this analysis is to provide a conclusive answer to the question of whether or not ADR markets are completely efficient, and we claim that even though one could use a different methodology to tackle the essential point of this study, the qualitative conclusions will not change. We purposely choose to focus on highly traded stocks, where we would least likely find arbitrage opportunities and calculate arbitrage profits as sparingly as possible. In this fashion, the resulting estimates for overall forgone profits can be taken as unquestionably positive and significant. Moreover, the price comparison is done taking into account all possible transaction costs and with a sampling methodology that minimizes the possibility of using stale quotes to make invalid price comparisons.

The results of this work suggest that ADR stocks are traded in markets that are not completely integrated and are also not fully efficient. Our estimate of the amount of profits that could have been made by a simple arbitrage rule reveals just how inefficient these markets are. Although the tests show that they are not too far from full efficiency, we expect all other cross-listed stock markets which are less developed and include less heavily traded stocks to exhibit lower degrees of efficiency and integration. Moreover, we also provide the first point estimate of the no arbitrage band, which can be considered a measure of the degree of market efficiency the markets exhibit and used for comparing other cross-listed markets with a trading overlap. The rest of the paper is organized as follows: Section 2 proposes several important data refinements, making possible the tests of lack of arbitrage opportunities in the market presented in Section 3. Finally, Section 4 summarizes the results, draws conclusions and proposes some ideas for future research.

2. Definitions and data

2.1. The construction of the price discrepancy series

The data set developed for this work includes several crucial refinements, with the most relevant being that we concentrate on quotes rather than trade data. This is important for several reasons, including the fact that we are in this way able to incorporate the bid-ask spreads a potential arbitrageur faces. Also, quotes are much more abundant than trades.

To understand an arbitrage operation, it is important to define the financial operation that translates ADRs into underlying shares and vice versa. ADRs represent a specific number of underlying shares kept aside in the home market, where the depositary bank can create new receipts when the demand for the ADRs is greater than their supply. When the demand falls short of supply, cancellations of DRs would simply reverse this process. Thus, the number of ADRs in the market varies depending on demand, in a phenomenon commonly known as “flowback”.[3] The depositary will typically process the cancellation of ADRs on a same-day basis (Pulatkonak and Sofianos, 1999), with a cost of about 5 cents.

To make a complete comparison between two different versions of a cross-listed stock, one must be able to assess the proper spot exchange rate at the exact time of the comparison. The intradaily French franc/US$ exchange rate data were obtained from Olsen and Associates, and it is sampled every minute of the trading overlap. In the search for arbitrage opportunities, we opt for matching quotes from both markets with a maximum time stamp difference of 1 s, in this way eliminating the problem of nonsynchronous sampling. As quotes enter both markets irregularly, this methodology naturally produces a data set with unevenly sampled observations.

We refer to the bid price in New York as B_{NY}, the ask in this market as A_{NY} and to the counterpart prices in Paris as B_{Pa} for the bid and A_{Pa} for the ask. As for the FF/US$ exchange rate, the spot bid price at time t is defined as S_{B}, while the ask exchange rate is S_{A}, both expressed as French currency per one US$.

We will incorporate the stocks’ and foreign exchange bid-ask spreads into the definition of the price discrepancy variable (D) by refining it as:

$$D = \begin{cases} B_{\mathrm{NY}} - A_{\mathrm{Pa}}/S_{\mathrm{B}} & \text{if} \quad B_{\mathrm{NY}} > A_{\mathrm{Pa}}/S_{\mathrm{B}} \\ B_{\mathrm{Pa}}/S_{\mathrm{A}} - A_{\mathrm{NY}} & \text{if} \quad B_{\mathrm{Pa}}/S_{\mathrm{A}} > A_{\mathrm{NY}} \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

[3] Because most ADR programs are nowadays ‘sponsored’ —meaning that their underlying company works with the depositary bank to ensure their correct functioning unless the stock is completely de-listed from the American market, this phenomenon rarely occurs on a large scale.

with its relative version (D_{rel}) defined as:

$$D_{\text{rel}} = \frac{D}{(0.5B_{\text{NY}} + 0.5A_{\text{NY}})} \tag{2}$$

In an efficient market setting and once translated into a common currency, we would expect the two prices of a cross-listed security to be very close to each other at any given time. Therefore, there would exist an overlap between the bid-ask spreads of both stocks. In view of this, our definition of the price discrepancy variable is set to zero in such instances of stock parity equilibrium. Profitable arbitrage of mispriced cross-listed securities, however, can only occur when there is no overlap between the bid-ask spreads, such that the ask price of the stock to be bought is actually lower than the bid price of the stock to be sold in an arbitrage strategy. As it is now defined, the D variable precisely measures this difference.

2.2. Descriptive statistics

Our exercise uses price comparisons from French stocks cross-listed in the US, as well as American stocks cross-listed in France. For the French side of the market, the source is the Base de Données de Marché (BDM) Paris Bourse Data Base, which in turn draws from the records from the SUPERCAC Electronic trading system. For the American data, the source is the Trade and Quote (TAQ) database of the New York Stock Exchange (NYSE). The time period is from April 7, 1997 to March 24, 1998. We examine the prices over the overlap period when both markets are open (i.e., 9:30 a.m.–11:00 a.m. New York time or 3:30 p.m.–5:00 p.m. Paris time). The 10 stocks included are some of the most heavily traded dually listed securities in these markets.[4]

We define the explicit costs involved in the arbitrage as c, which is an underestimation of the no-arbitrage band for not including any risks involved in the operation. This value will include the commissions from both stock markets, as well as the 5 cent DR subscription/cancellation fee. According to Willoughby (1998), contrary to the trend other markets showed up to 1996, NYSE commissions did not budge, remaining at 13.3 basis points per stock traded. Moreover, even though he does not explicitly mention stock market commissions, Willoughby goes on to declare that the Paris Bourse retained its crown in 1997, winning bragging rights as the world's cheapest place to trade stocks.[5] To define a cautiously large c, we assume that commission fees are 13.3 basis points for both markets.

Table 1 presents summary statistics for the 10 stock pairs analyzed in the paper. By including the bid-ask spread in the definition of the price discrepancy (D), we eliminate the problem that would be caused otherwise when defining a constant no-arbitrage band. As we base our exercise on the relative version of the price discrepancy, the 5 cents are divided by the average New York price in the sample to obtain an approximate and constant relative measure of transaction costs. Adding the proposed 13.3 basis points of commission fees in each market, the last column of Table 1 reports the relative size of the explicit costs the strategy incurs, i.e. the value of c.

[4] Specifically, the stock pairs are those with the fewest minutes without a quote from either market.

[5] Including effective bid-ask spreads (which we have included in D), the French stock market exhibited average total trading costs of 26.7 basis points (beating the NYSE, at 31.5 basis points).

Table 1
Summary descriptive statistics for the quote data in the sample

Traded in market	Stock name	Ticker symbol	Number of quotes	Average price	Comparable price	Relative spread	Transaction costs c (relative terms)
N.Y	Alcatel Alsthom	ALA	25603	25.81	129.05	1.41	0.305
Paris	Alcatel Alsthom	ALA	100337	763.71	127.92	0.18	0.305
NY	AXA	AXA	19585	37.41	74.82	4.73	0.334
Paris	AXA	AXA	102860	435.10	72.88	0.14	0.334
NY	American Express	AXP	226335	79.92	79.92	0.35	0.330
Paris	American Express	AXP	28494	461.60	77.32	1.33	0.330
NY	General Electric	GE	212418	93.87	93.87	0.42	0.320
Paris	General Electric	GE	12549	549.35	92.02	1.80	0.320
NY	Gillette	GIL	305290	69.24	69.24	0.32	0.338
Paris	Gillette	GIL	20296	413.21	69.22	0.97	0.338
NY	General Motors	GM	180360	62.44	62.44	0.48	0.346
Paris	General Motors	GM	29406	376.25	63.03	1.29	0.346
NY	McDonald's	MCD	136727	49.33	49.33	0.51	0.368
Paris	McDonald's	MCD	16968	293.03	49.08	0.95	0.368
NY	Phillip Morris	MO	340976	43.05	43.05	0.49	0.382
Paris	Phillip Morris	MO	22221	257.45	43.12	1.14	0.382
NY	Total Fina Elf	TOT	40349	51.71	103.42	0.62	0.315
Paris	Total Fina Elf	TOT	84502	608.89	101.99	0.26	0.315
NY	United Technologies	UTX	137979	79.68	79.68	0.44	0.330
Paris	United Technologies	UTX	24133	461.51	77.30	1.27	0.330
FF/USD			31592	5.97		0.026	

Table 2 depicts the basic statistics of the discrepancy series, displaying the found disequilibria as measured relative to the price of the stock (D_{rel}). The discrepancies are enclosed between ±3% of the price. In fact, of the 85,178 matched observations in the sample, 99.98% fall in the (−2%, +2%) range. As a representative example, Fig. 1 shows the relative price discrepancy for United Technologies (UTX), shown for the 1 year of sampled observations, during the trading overlap. Aside from a higher incidence of discrepancies during the first

Table 2
Relative price discrepancies for contemporaneously sampled quote data

Ticker	Mean	Minimum	Maximum	Standard deviation	No. of price comparisons
ALA	0.022	−1.95	1.55	0.18	4098
AXA	0.029	−2.58	1.55	0.26	2986
AXP	0.008	−1.15	1.74	0.12	13571
GE	−0.008	−1.75	1.38	0.15	10895
GIL	−0.011	−2.45	1.75	0.25	7354
GM	0.008	−2.96	2.17	0.14	12756
MCD	−0.013	−1.58	3.34	0.18	6470
MO	0.009	−1.84	2.10	0.16	13253
TOT	−0.012	−2.18	1.99	0.24	4525
UTX	−0.002	−1.36	1.42	0.13	9270
All	−0.001	−2.96	3.34		85178

$D_{\text{rel}} = D/(0.5 \times B_{\text{NY}} + 0.5 \times A_{\text{NY}})$, in percentages.

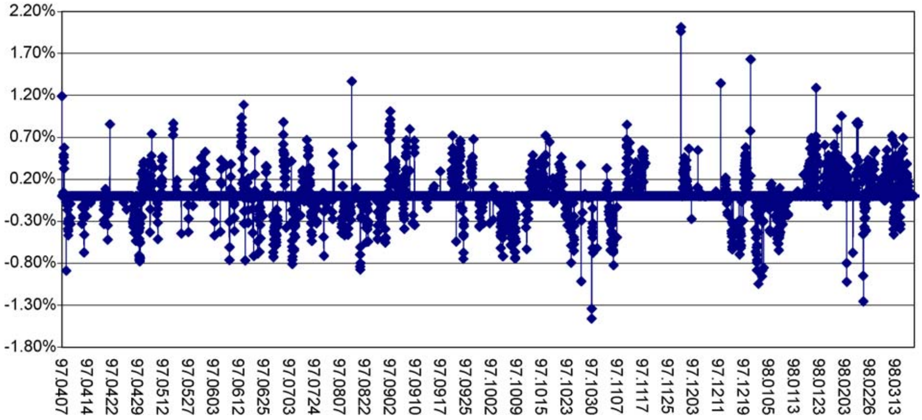

Fig. 1.

few minutes of the trading overlap, when markets are adapting to each other, there are no apparent patterns as to when these discrepancies occur within the overlap. Fig. 2 graphs the average absolute value of the price discrepancies per minute of the trading overlap for the 10 stock pairs in our sample.

3. Tests and results

The exercise takes second-matched quotes and proposes a simple trading rule to perform an arbitrage strategy whenever the absolute value of the price discrepancy exceeds an arbitrage trigger *K*. The hypothetical arbitrageur modeled by the trading rule pays the cancellation (or subscription) fee and the corresponding commissions in both stock markets. The key feature of the strategy will be to choose a proper value for *K* and we begin by using

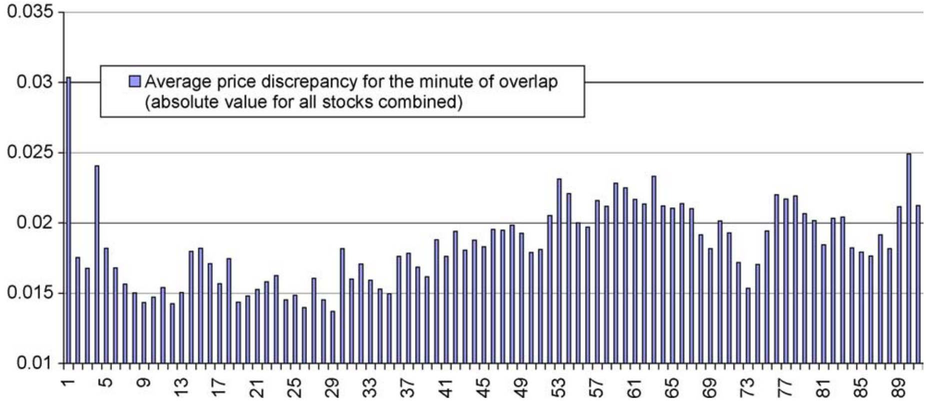

Fig. 2.

Table 3
The percentage of observations outside the threshold bands

Ticker	Total no. of observations	% Instances outside c	% Instances outside $2c$	% Instances outside $3c$	% Instances outside K^*
ALA	4098	7.5	2.4	0.9	2.8
AXA	2986	13.0	3.3	1.0	4.9
AXP	13571	3.7	0.6	0.1	0.9
GE	10895	5.5	0.9	0.1	1.6
GIL	7354	10.2	4.8	1.7	5.4
GM	12756	3.4	0.5	0.2	1.2
MCD	6470	5.6	1.0	0.2	2.5
MO	13253	4.0	1.0	0.3	1.9
TOT	4525	10.4	3.3	1.5	4.0
UTX	9270	4.9	0.7	0.1	1.4
All	85178	5.8	1.4	0.4	2.1

Where K^* is a constant value for all stocks, and equal to 0.563%.

the explicit transaction costs constant c. In this fashion, the strategy follows the available price comparisons looking for instances in which $|D_{\text{rel}}| > c$, buying as much as it can of these mispriced securities, which is the minimum of the two blocks of stocks being offered and demanded at the relevant ask and bid sides of the strategy. Table 3 displays summary statistics for the number of observations outside this threshold.

To calculate the profits obtained by the trading rule, we go forward in time to the settlement date, $t+3$. As a proxy for the foreign exchange risk, we use the worst exchange rate of the $1\frac{1}{2}$ h trading overlap to make the comparison when we calculate the profits obtained from it.[6] The resulting total profits for each of the stocks are presented in Table 4. When the threshold constant is set at c, the profits for about half the stocks are negative, providing a total profit for the 10 stocks that is very close to zero. This result is cropped by our set up and it is explicitly meant to model the implicit risks of the operations.

Continuing with the exercise, we proceed to increase the threshold constant K to $2c$ and up to $3c$. Once again, Table 1 provides the specific size of these new threshold constants for each of the stock pairs, while Table 3 shows the reduced number of instances in which the relative price discrepancy exceeds $2c$ and $3c$. Applying the trading rule one more time provides drastically different results. Table 4 now shows that the rule using $K = 2c$ provides significant positive profits of US$ 69,449 and it provides profits worth US$ 38,851 if it only trades when the relative price discrepancy exceeds $3c$.

By triggering an arbitrage operation just above the transaction costs included in c, the trading rule was not successful because it was engaged in too many instances with relatively small mispricings. Therefore, under the assumption that all transaction costs are accounted for (explicit and implicit), we now classify mispricings outside the $(-2c, +2c)$ interval as forgone arbitrage opportunities. Whether the magnitude of profits provided by the trading rules are large or small should not be our criterion for judging its successfulness. The most

[6] Naturally, this does not imply that, a priori, the exchange rate could not have gone even further in the wrong direction for arbitrage profits. This penalization may be too harsh for the average profits, but it is better to exaggerate our costs, such that arbitrage profits are more robust.

Table 4
Total profits derived from the arbitrage trading rule triggered by the C constant

Ticker	Total profits when $K=c$ (\$)	Total profits when $K=2c$ (\$)	Total profits when $K=3c$ (\$)	Total profits when $K=K^*$ (\$)
ALA	12446	19933	3929	24270
AXA	−1947	7232	2842	7232
AXP	−7807	182	−197	−377
GE	1925	5026	2,128	5255
GIL	−3027	1587	750	−572
GM	−6962	2944	3065	2964
MCD	−1438	1382	1048	1463
MO	2369	5386	2520	5468
TOT	9230	26288	22535	26920
UTX	−4756	−514	228	−643
Total	32	69449	38851	71980

Where K is the triggering variable and $K=K^*$ is the triggering level that maximizes arbitrage profits for our trading rule.

important observation to make is that profits become positive when we increase the size of the trigger constant K.

The actual size of the total profits obtained may be an underestimation of all potential arbitrage profits for several reasons. First, our matching methodology, which only provides a comparison when new quotes enter both markets, at most 1 s apart from each other may be too restrictive; we would expect more quotes to become stale long after our 1 s sampling criteria. Second, there may be more stocks available in the order book which an arbitrageur can buy or sell, but do not appear in our data set, which only displays the innermost sides of the market (aside from the upstairs market in New York, which is hidden from our data set). Third, in an attempt to quantify foreign exchange risk, we have calculated profits using the worst exchange rate of the trading overlap on the settlement date. Lastly, the stocks in our sample are only a sub-sample of all the cross-listed stocks from these markets, and they are the most heavily traded ones. It may be that dual stocks with a lower trading frequency present larger arbitrage opportunities (see Kaul and Mehrotra, 2000).

Recognizing that by calculating aggregate profits above a constant threshold we are adding discrepancies of significantly different magnitudes, Table 5 presents disaggregated profits for each of three sub-categories: category 1 represents total profits obtained only when $|D_{\mathrm{rel}}|$ is between c and $2c$; category 2 when $|D_{\mathrm{rel}}|$ is between $2c$ and $3c$, and category 3 when $|D_{\mathrm{rel}}|$ is above $3c$. As we can see from this exposition, the average profits for category 1 (the times when the trading rule is triggered with a relatively small price discrepancy) are negative for each and every one of the stocks. On the other hand, average profits for categories 2 and 3 are significantly positive for practically all stocks.[7] Naturally, average profits for category 3 are largest, for these represent instances in which the prices are significantly out of line.

[7] The one stock that exhibits negative profits for $K=3c$, American Express, has only eight observations in this category. The negative value is a product of the variability implied in the penalized trading rule.

Table 5
Average and total profits according to the size of the price discrepancy sub-categories

Stock pair	Mean profits category 1 ($)	Total profits category 1 ($)	Mean profits category 2 ($)	Total profits category 2 ($)	Mean profits category 3 ($)	Total profits category 3 ($)
ALA	−35.65	−7487	256.13	16004	3929.03	3929
AXA	−31.77	−9179	63.62	4389	2842.08	2842
AXP	−18.84	−7989	5.73	332	−516.10	−197
GIL	−7.75	−3101	12.78	2897	2128.75	2128
GE	−9.08	−4614	10.59	837	750.24	750
GM	−26.63	−9907	−2.81	−120	3065.48	3065
MCD	−9.34	−2820	6.81	333	1048.65	1048
MO	−7.65	−3016	31.15	2866	2520.23	2520
TOT	−53.13	−17057	46.90	3752	22536.40	22535
UTX	−10.96	−4242	−12.59	−742	228.69	228
Total		−69416		30550		38851

Where category 1 represents relative price discrepancies between c and $2c$. Category 2 represents relative price discrepancies between $2c$ and $3c$, and category 3 represents relative price discrepancies above $3c$.

Further, by varying the size of K we can find the exact value between c and $2c$ for which total profits become zero. The no-arbitrage band must lie somewhere inside the $(-2c, +2c)$ range, and outside $(-c, c)$. We approximate a more precise no-arbitrage band by closing in from above and below,[8] defining finer D categories, until we find a threshold for which the profitability of the trading rule is exactly eliminated and it is at this value which we will now define as K^*, where we establish a point estimate of the no-arbitrage band[9]: $K^* = \pm 0.563\%$. Once again, Table 3 shows the number of observations outside this threshold, while Table 4 shows that total profits added up across stocks are indeed positive at K^* and equal to an aggregate total of US$ 71,980.

4. Conclusions and some possible extensions

This paper established a point estimate for the no-arbitrage band of ±0.563%, inside which a mispricing cannot be profitably arbitraged due to transaction costs and foreign exchange risk. About 2.1% of the observations in our sample were outside this band and they were thus classified as arbitrage opportunities.

At this point, we may want to ask why these profitable disequilibria appear in such a highly developed market. First and foremost, the arbitrage opportunities we are defining are not without risk. If all investors in the market are risk averse, then the premium included in the no-arbitrage band may not compensate for the risk that investors face when they undertake an arbitrage strategy. It is implausible, however, that this is the reason why the

[8] Because of the implied risk of the operation, the function relating K to total profits may not be linear.

[9] This process brought us to the first category with average positive profits (equal to US$ 2.47, with 81 observations). This category represented D_{rel} observations between 0.558 and 0.567; the point estimate offered is the average of these two numbers.

deviations exist, as the degree of risk aversion necessary to explain such profit figures would have to be extremely large.

As Shleifer and Vishny (1997) point out, one reason why we could expect to observe arbitrage opportunities in a relatively efficient market is the fact that capital for undergoing risky arbitrage operations may not be readily available. Moreover, professional arbitrage is conducted by a few highly specialized institutions who can trade electronically in both markets and have the lowest transaction costs. In this fashion, we could present the profits obtained by the trading strategy proposed (roughly US$ 70,000) as indicative of the opportunity cost of hiring a financial specialist to monitor this market.

One final explanation may be that the small and infrequent arbitrage opportunities we observe evidence a liquidity provision that investors could occasionally consider paying. More explicitly, suppose there is a French stock owner who believes to have information implying that the price of the cross-listed Total Fina Elf stock will soon drop. At this time, however, the French market is particularly thin. In such a situation, it may be profitable for the investor to quote a price significantly under the current ADR price of the stock and thereby draw arbitrage demand to buy his then 'underpriced' securities.

Furthermore, our results on the integration of the markets are in accordance with Kleidon and Werner's, implying that the markets are essentially disintegrated; a statement we can make in a dichotomous fashion. As for market efficiency, this is a concept that we can treat as a quantitative, not a qualitative one. We presented evidence that these markets are not completely efficient, provided a first point estimate of exactly how inefficient they are and proposed our assessment of the no-arbitrage band (K^*) as a sensible proxy variable for measuring the efficiency of such markets. Lastly, following Kaul and Mehrotra's results indicating that less traded stock pairs present higher profit opportunities, we hypothesize that other similar but probably less efficient in their own right dual markets would exhibit lower degrees of market efficiency than the highly traded American and French stocks of the analysis presented.

The bottom line of this study was to determine whether or not dual stock markets are integrated, defined by a situation where there is a common set of investors trading these stock pairs; and if these markets are efficient, as measured by a lack of arbitrage opportunities. More precisely, we refer to disintegrated markets as those in which different investors arrive at stock prices of similar stocks independently. On the other hand, forgone arbitrage opportunities reveal a market-wide reaction lag on disequilibria, revealing less than full efficiency. Arbitrage opportunities are to be expected in disintegrated markets, since the parity equilibrium is enforced by arbitrage forces. Naturally, the successful agent has the incentive not to divulge its profitable operations, so that the inefficiencies exposed can only be puzzling as far as the length of their existence.

Along this line of research, we recognize that further examination of the sources and dynamics of the price discrepancies is warranted. One possible next step is to see how short-lived arbitrage opportunities are. In particular, if arbitrageurs are indeed maintaining the law of one price in this market, we would expect to see a nonlinear mean reversion of the price discrepancy, since small misalignments cannot cover for transaction costs. Suarez (2005) proposes a threshold autoregressive model (TAR) to analyze this possibility. Also in this direction, Gramming et al. (2001) develop a study addressing two questions: (1) where does ADR price discovery occur and (2) how do international stock prices adjust to an exchange rate shock. Their findings suggest that the information origin, as well as which market tends to adjust more quickly to the intradaily deviations from stock price parity, depends on trading patterns and the degree of multinationality of the stocks.

In summary, previous related results in the literature using comparable intradaily data had come to contradicting results regarding the existence of arbitrage opportunities in the market for cross-listed stocks. The evidence presented in this analysis indicates that there are unexploited profit opportunities, both for ADRs traded in the US and for American stocks cross-listed abroad, with this last comparison being the first study of such a market.

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