Intraday Arbitrage in Emerging Market American Depositary Receipts

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Abstract

This paper represents the first known examination of intraday arbitrage in emerging market American Depositary Receipts (ADRs). Using a sample of Brazilian ADRs, we find that there are little arbitrage opportunities for the ordinary trader as the price differences are rarely larger than the transactions costs. However, we do find that financial institutions can regularly engage in profitable arbitrage of ADRs as their transactions costs are much lower than ordinary traders.

Key Words: Arbitrage; American Depositary Receipts; Intraday

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Abstract

This paper represents the first known examination of intraday arbitrage in emerging market American Depositary Receipts (ADRs). Using a sample of Brazilian ADRs, we find that there are little arbitrage opportunities for the ordinary trader as the price differences are rarely larger than the transactions costs. However, we do find that financial institutions can regularly engage in profitable arbitrage of ADRs as their transactions costs are much lower than ordinary traders.

1. Introduction

American Depositary Receipts (ADRs) are certificates sold in the U.S. markets that represent ownership of shares in foreign-owned corporations. They allow a U.S. investor to buy shares of foreign-owned companies in the same way that they would buy stocks in U.S. corporations. Due to their convenience, and U.S. investors' willingness to invest abroad, ADRs have quickly become a significant part of the U.S. investor choice set. Indeed, as of 2000, investment by U.S. Institutions in ADRs reached four percent of total equity assets in domestic portfolios.[1]

This short paper examines a simple question related to these ADRs: Is intraday arbitrage possible in emerging market ADRs? That is, since an ADR represents the underlying stock sold in the foreign market, the prices of the ADR and the underlying stock should be the same at all times after adjusting for exchange rates. However, significant deviations from the one price would result in arbitrage opportunities that could easily be realized by investors. In this paper we examine whether these deviations exist on an intraday basis and if they are enough to create profitable arbitrage opportunities.

The importance of this paper is not that it is the first paper to examine arbitrage in ADRs. Indeed, many papers, i.e., Rosenthal (1983), Maldonado and Saunders (1983) and Kato, Linn and Schalheim (1992), have examined this issue using monthly, weekly or daily return data. Moreover, the paper is not the first paper to use intraday data to examine ADR arbitrage as Miller and Morey (1996), have also used intraday data to test arbitrage on European ADRs. Rather, the importance of this paper is that it is the first paper, to our knowledge, that investigates the intraday arbitrage opportunities in emerging market ADRs. This is an important extension of the work on arbitrage in ADRs as emerging market stock exchanges often do not operate with same level of efficiency as their developed country counterparts and because the transactions costs can be quite different in emerging stocks markets as compared to developed markets.

The paper is organized as follows. In Section 2 we describe the data and the methodology used. Section 3 provides some information on transactions costs. Section 4 presents the results and Section 5 concludes the paper.

2. Data and Methodology

Our rationale in the study was to use data that closely approximates what a trader would actually examine when conducting arbitrage. Hence, our approach to collecting the data was to gather cases in which we could find a price quotation for the underlying share, the ADR (listed in the U.S. market), and the exchange rate during the same minute of time. Moreover, that minute of time had to be when both the underlying and U.S. markets were open for trading.

[1] See Stock (2002).

The collection of these data was extremely onerous as it required that we match hundreds of thousands of quotations. For this reason we selected only a limited number of ADRs to examine and then only examined them over a four week period. Furthermore, since this paper examines the ability to conduct arbitrage, we needed precise trading costs information from the country in which the underlying stock trades. Given these difficulties we limited our sample to the ADRs of only one emerging market country, Brazil.

We choose Brazil for a number of reasons. First, this country has been trading ADRs for a substantial period of time and hence represents a situation where the ADR market is well developed. Second, the markets in Brazil are open during the entire U.S. trading day as opposed to other emerging markets such in India or Thailand that have no overlap with the U.S. market. Third, Brazil represents a country where we have clear information about the trading costs of conducting arbitrage. Indeed, in many emerging market countries this information is not nearly as transparent.

Thus, for the study we examined the 11 most traded Brazilian ADRs listed on the NYSE as of January 2001. These ADRs are listed in Table 1. The table provides the annual volume of the ADRs, the symbols of the ADRs as listed in the New York and Sao Paulo stock exchanges, the type of stock that the ADR represents, the number of underlying shares that each ADR represents, and the number of shares that the listed price of the company in the Sao Paulo exchange represents.[2]

To examine the opportunities for arbitrage we collected intraday price data from three sources: The New York Stock Exchange for the ADR prices, the Sao Paulo Stock Exchange for the underlying stock prices and the Brazilian central bank for the reais/dollar exchange rate.[3] All data are taken on an intraday basis during the period when the two stock markets overlap, 9:30-4:00pm (U.S. Eastern Standard time[4]) over the period for May 21, 2001 through June 18, 2001.[5] We found that there were 9373 cases for which we had a quote for the Brazilian, ADR, and exchange rate markets during the same minute.

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[2] In the Sao Paulo exchange it is often the case that the price listed in the exchange represents significantly more shares than just one.

[3] For the exchange rate we used the latest informative exchange rate available from the Brazilian Central Bank. Moreover, it should be noted that the Brazilian central bank only provides quote data approximately every half-hour during the trading day. As a result, our data collection process is really to examine all situations where we have local and ADR traded prices during the same minute and then to just use the current exchange rate offered by the Brazilian Central bank at that time. Since there was very little volatility in the exchange rate during our sample period, the fact that we did not have minute by minute exchange rate data did not influence our results.

[4] The Sao Paulo Stock Exchange is open from 9am-4pm (U.S. Eastern Standard Time) and the New York Stock Exchange is open from 9:30am-4pm (U.S. Eastern Standard Time).

We then proceeded by examining the arbitrage possibilities from two distinct perspectives. First, we examined the arbitrage opportunities from the prospective of an ordinary U.S./Brazilian trader. Second, we investigated the opportunities for a major financial institution that operates in both the U.S. and Brazil. We used these two different perspectives as the transactions costs associated with arbitrage are considerably different for each perspective and obviously can influence the degree of arbitrage that is possible. The transactions costs for each of the three perspectives are described more in section 3 and then described in detail in an appendix to the paper.

For each of these two perspectives we looked at an arbitrage transaction originating in the U.S. (instigated by purchasing the ADR) and an arbitrage transaction originating in Brazil (instigated by purchasing the underlying stock). For the arbitrage originating in the U.S. we used an arbitrary amount of US$100,000 to estimate the number of ADRs we could buy using the ask price in each trade. We then computed the amount we would receive if we have converted the ADRs in Brazilian stocks and sold the stocks by the bid price in the Brazilian market. We then converted this amount to US dollars using the current "ask" exchange rate provided by the Brazilian Central Bank[6] to determine the dollar return from the transactions. We proceeded in the same way for arbitrage originating in Brazil. Specifically, we used R$232,000 (the equivalent amount in reais to US$100,000 at that time) and estimated the number of stocks we could buy using the ask price in each trade. Afterwards, we computed the amount we would receive if we have converted the Brazilian stocks in ADRs and sold the ADRs by the bid price in the US market. Converting the amount in reais using the current "bid" exchange rate, we have determined the net amount we would receive at the end of the transaction.

3. Transactions Costs

To accurately examine arbitrage possibilities it is important to use the correct transactions costs involved in the arbitrage transaction. To ascertain these costs we called Brazilian and U.S. financial institutions and brokerage firms.

In our analysis of the transactions costs we found that financial institutions have much lower transactions costs than an ordinary trader. These lower costs stem from two sources. First, since these financial institutions operate in both the Brazilian and U.S. equity markets there are no broker fees since

[5] It should be noted that during this four week period there were no major economic or financial shocks to the U.S. or Brazilian markets.

[6] We used the "ask" foreign exchange rate to convert reais back to dollars as this represents the true price at which the Brazilian foreign exchange market is willing to sell dollars for reais, according to the informative exchange rate provided by the Brazilian Central Bank. We used the "bid" foreign exchange rate as this represents the price that Brazilian foreign exchange market is willing to buy dollars.

the transactions are conducted in house. Second, and more importantly, there are no taxes for financial transactions in Brazil conducted by financial institutions that operate in Brazil. This is compared to a 0.38 percent tax on the real volume of any trade that an ordinary trader would have to pay.

The combined effect of these lower costs is quite dramatic. For example, for an ordinary trader the costs of conducting ADR arbitrage originating in the U.S. are as follows. First, there is a U.S. broker fee of $0.05 for each ADR bought in the NYSE. Then there is a conversion fee of US$0.05 for each ADR converted to Brazilian stocks. Next, the underlying stock must be sold in the Brazilian market. The typical costs is a Brazilian broker fee equal to 0.5 percent of the real volume of the transaction in the Brazilian market plus a fee charged by the São Paulo Exchange equal to 0.035 percent of the real volume of the transaction, plus a Brazilian tax for financial transactions equal to 0.38 percent of the real volume. Finally, to convert the reais back into dollars, there is a fixed cable fee in the amount of US$7.50 per transaction. Conversely, for financial institutions, the only costs are the ADR conversion fee of a nickel per share and the fee charged by the São Paulo Exchange equal to 0.035 percent of the real volume of the transaction.

In an appendix to the paper we provide all the various transactions costs used in each type of arbitrage transaction, whether originating in the U.S. or Brazil.

4. Results

4.1. Arbitrage Opportunities

The results of the arbitrage opportunities test are presented in Tables 2 and 3. Specifically, Table 2 presents the results for arbitrage opportunities for the ordinary trader and Table 3 shows the results for a typical financial institution.

The results for the ordinary trader show similar findings to what Miller and Morey (1996) found in their examination of intraday arbitrage in European ADRs. That is, there seems to be little opportunity for profitable arbitrage. Indeed for the ordinary trader (with arbitrage originating in Brazil) there were only 29 of 9373 cases (0.03 percent of the time) for which profitable arbitrage was found. For the ordinary trader (with arbitrage originating in the U.S.) the results are similar as only 16 of 9373 cases showed any profitable arbitrage. Moreover, when arbitrage was possible, the gains from the arbitrage were quite small, averaging only about $136 per trade. Since we are using a $100,000 base this amounts to about to a .01 percent return.

The results for the Brazilian financial institution, however, are quite different. They show that there is often a profitable arbitrage opportunity available. In approximately 17 percent of the cases (1620 of 9373), arbitrage is profitable when originating from Brazil. Whereas 8 percent of the time (634 out of 9373) is arbitrage profitable when originating from the U.S.

4.2 Timing of the Arbitrage Opportunities

We postulated that the arbitrage opportunities may be disproportionately arising during a particular period of the trading day. For example, we hypothesized that we would see more arbitrage opportunities at the beginning and the ending of the overlap as it is well known that stock markets display a U-shaped pattern in regards to intraday volatility (see Werner and Kleidon (1996) for example). That is, since both markets are open at the same period (except for the 9:00-9:30am) and since stock markets have been shown to have higher volatility at the beginning and ending of the trading day, it may be the case that there are larger price differences between the ADR and underlying shares at these times.

To test this hypothesis we broke the arbitrage opportunities down by the time of the day. Specifically we organized the cases where arbitrage was possible by each half-hour that both markets were open, starting with 9:30-9:59am (Eastern Standard Time). Moreover, since the arbitrage opportunities we so few for the ordinary trader, we only examined the arbitrage opportunities for financial institutions.

The results organized by the time of the day are presented in Table 4. The results show that arbitrage (whether originating in Brazil or the U.S.) is least likely to be available during the middle of the trading day, i.e. from 12:00pm-12:59pm. However, at the beginning and ending of the overlap, arbitrage opportunities are more likely to be available. This is particularly true in the beginning of the overlap for arbitrage originating in Brazil and at the end of the overlap for arbitrage originating in the U.S.

5. Conclusion

This short paper represents the first empirical examination of intraday arbitrage in emerging market ADRs. Specifically, in this paper we have examined the arbitrage opportunities in 11 heavily traded Brazilian ADRs using intraday data. Using precise transactions costs data, we find that for ordinary traders, the arbitrage opportunities are indeed few and far between. However, in the case of financial institutions that operate in both Brazil and the U.S., we find that ADR arbitrage is often quite profitable. Indeed, for arbitrage originating in Brazil we find that in 17 percent of the cases in our sample, there are indeed arbitrage opportunities to exploit after adjusting for transactions costs. Furthermore, we find that the incidence of these arbitrage opportunities is higher at the beginning and ending of the U.S. trading day when volatility is the highest.

The implication of our results is that ADR arbitrage may actually be profitable when dealing with emerging market ADRs. Although our time frame is only four weeks, only for one country and only uses 11 ADRs, our results indicate that the special tax laws for financial institutions seem to create enough opportunities to make ADR arbitrage in emerging markets a profitable undertaking.

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Appendix: Transactions Costs

The transactions costs are for the two perspectives: the ordinary trader and a typical financial institution. The transactions costs information was given to us directly by individuals at financial institutions and is consistent with the actual transactions costs in the Spring of 2001. The transactions costs are as follows:

From the ordinary trader perspective, the transaction costs involved with arbitrage originating in the U.S. are:

- A US broker fee equal to US$0.05 for ADR traded in the NYSE.
- A conversion fee of US$0.05 for ADR converted to Brazilian stocks.
- A Brazilian broker fee equal to 0.5 percent of the *real* volume of the transaction in the Brazilian market.
- A fee charged by the São Paulo Exchange equal to 0.035 percent of the *real* volume of the transaction.
- A Brazilian tax for financial transactions of 0.38 percent of the *real* volume.
- A fixed cable fee in the amount of US$7.50 per transaction.

From the ordinary trader perspective, the transaction costs involved with arbitrage originating in Brazil are:

- A Brazilian broker fee equal to 0.5 percent of the *real* volume of the transaction in the Brazilian market.
- A fee charged by the São Paulo Exchange equal to 0.035 percent of the *real* volume of the transaction.
- A Brazilian tax for financial transactions of 0.38 percent of the *real* volume.
- A US broker fee equal to US$0.05 for ADR traded in the NYSE.
- A conversion fee of US$0.05 for Brazilian stocks converted to ADRs.
- A SEC fee equal to 1/30,000 times the dollar volume of the transaction in the US market.

From the perspective of a financial institution (that is located in both Brazil and the U.S.), we have the following transaction costs when the transaction is initiated in the US:

- A conversion fee of US$0.05 for ADR converted to Brazilian stocks.

- A fee charged by the São Paulo Exchange equal to 0.035 percent of the *real* volume of the transaction.

From the perspective of a financial institution, we have the following transaction costs when the transaction is initiated in Brazil:

- A fee charged by the São Paulo Exchange equal to 0.035 percent of the *real* volume of the transaction.
- A conversion fee of US$0.05 for Brazilian stocks converted to ADRs.
- A SEC fee equal to 1/30,000 times the dollar volume of the transaction in the US market.

Table 1: Description of Brazilian ADRs

Company	Industry	Volume	NYSE	BOVESPA	Type[1]	Ratio[2]	n. BOV[3]
Petroleo Brasileiro SA – PETROBRAS*	Oil & Gas Exploration	341,706,720.00	PBR	PETR3	Common	1:1	1
Telecomunicacoes de Sao Paulo	Telecommunications	262,763,500.00	TSP	TLPP4	Preferred	1:1,000	1,000
Tele Norte Leste Participacoes SA	Telecommunications	246,228,988.00	TNE	TNLP4	Preferred	1:1,000	1,000
EMBRATEL Participacoes SA	Telecommunications	229,412,000.00	EMT	EBTP4	Preferred	1:1,000	1,000
TELESP Celular Participacoes SA	Telecommunications	100,412,500.00	TCP	TSPP4	Preferred	1:2,500	1,000
Companhia de Bebidas das Americas - AMBEV	Beverages	76,945,400.00	ABV	AMBV4	Preferred	1:100	1,000
Empresa Brasileira de Aeronautica SA – EMBRAER*	Aerospace	67,143,000.00	ERJ	EMBR4	Preferred	1:4	1
Tele Centro Oeste Celular Participacoes SA	Telecommunications	67,076,800.00	TRO	TCOC4	Preferred	1:3,000	1,000
Uniao de Bancos Brasileiros SA - UNIBANCO	Financial Services	62,417,600.00	UBB	UBBR11	Unit**	1:500	1,000
Companhia Paranaense de Energia - COPEL	Utilities	61,890,400.00	ELP	CPLE6	PreferredB	1:1,000	1,000
ARACRUZ Celulose SA	Paper Production	53,766,000.00	ARA	ARCZ6	PreferredB	1:10	1

Notes:

* These companies only started their ADR listings in the summer of 2000 (Petrobras in August 2000 and Embraer in July 2000). To calculate their volume, we annualized the volume trading dividing by 5 and 6, respectively, and multiplying by 12.

** Every "unit" of UNIBANCO traded in Sao Paulo Stock Exchange (BOVESPA) corresponds to one preferred stock of UNIBANCO and one class B preferred stock of UNIBANCO Holdings. One ADR of UNIBANCO traded in NYSE corresponds to 500 units.

Volume = number of ADRs traded in year 2000.

Ratio = ADR/stocks

n. BOV = the price in BOVESPA is related to this number of stocks.

Table 2: Arbitrage Possibilities for the Ordinary Trader

	Arbitrage Originating in Brazil				Arbitrage Originating in U.S.			
Company	# of matches	# of arbitrage cases	% of matches where arbitrage is possible	Average Magnitude of the Arbitrage (in reais)	# of matches	# of arbitrage cases	% of matches where arbitrage is possible	Av. Magnitude of the Arbitrage in (U.S. Dollars)
Petroleo Brasileiro SA - PETROBRAS*	920	1	0.11	741.03	920	0	0.00	0.00
Telecomunicacoes de Sao Paulo	112	14	12.50	2279.86	112	0	0.00	0.00
Tele Norte Leste Participacoes SA	2424	0	0.00	0.00	2424	0	0.00	0.00
EMBRATEL Participacoes SA	1476	1	0.07	213.12	1476	4	0.27	257.60
TELESP Celular Participacoes SA	1698	7	0.41	3572.68	1698	2	0.12	704.54
Companhia de Bebidas das Americas - AMBEV	653	1	0.15	4.39	653	6	0.92	391.00
Empresa Brasileira de Aeronautica SA - EMBRAER*	660	1	0.15	43.34	660	4	0.61	148.74
Tele Centro Oeste Celular Participacoes SA	552	3	0.54	327.16	552	0	0.00	0.00
Uniao de Bancos Brasileiros SA - UNIBANCO	130	0	0.00	0.00	130	0	0.00	0.00
Companhia Paranaense de Energia - COPEL	382	0	0.00	0.00	382	0	0.00	0.00
ARACRUZ Celulose SA	366	1	0.27	675.79	366	0	0.00	0.00
TOTAL	9373	29			9373	16		

Notes:

Average-magnitude = amount of profit from arbitrage/number of cases of arbitrage.

Table 3: Arbitrage Possibilities for a Brazilian Financial Institution

	Arbitrage Originating in Brazil				Arbitrage Originating in U.S.			
Company	# of matches	# of arbitrage cases	% of matches where arbitrage is possible	Average Magnitude of the Arbitrage (in reais)	# of matches	# of arbitrage cases	% of matches where arbitrage is possible	Average Magnitude of the Arbitrage (in US Dollars)
Petroleo Brasileiro SA - PETROBRAS*	920	149	16.20	411.17	920	28	3.04	238.95
Telecomunicacoes de Sao Paulo	112	41	36.61	2780.35	112	17	15.18	414.26
Tele Norte Leste Participacoes SA	2424	336	13.86	345.98	2424	39	1.61	332.74
EMBRATEL Participacoes SA	1476	96	6.50	688.74	1476	175	11.86	337.07
TELESP Celular Participacoes SA	1698	480	28.27	511.53	1698	28	1.65	353.26
Companhia de Bebidas das Americas - AMBEV	653	93	14.24	500.29	653	126	19.30	363.05
Empresa Brasileira de Aeronautica SA - EMBRAER*	660	58	8.79	480.75	660	194	29.39	290.41
Tele Centro Oeste Celular Participacoes SA	552	127	23.01	875.24	552	18	3.26	324.59
Uniao de Bancos Brasileiros SA - UNIBANCO	130	52	40.00	614.82	130	0	0.00	0.00
Companhia Paranaense de Energia - COPEL	382	116	30.37	757.23	382	3	0.79	338.65
ARACRUZ Celulose SA	366	72	19.67	472.12	366	6	1.64	109.74
TOTAL	9373	1620			9373	634		

Notes:
Average-magnitude = amount of profit from arbitrage/number of cases of arbitrage.

Table 4: Arbitrage Opportunities for Financial Institutions Organized by Time of the Day

	Arbitrage Originating in Brazil		Arbitrage Originating in U.S.	
Time (Eastern Standard Time)	# of arbitrage cases	% of cases occurring during this time	# of arbitrage cases	% of cases occurring during this time
9:30am-9:59am	173	10.69	57	9.00
10:00am-10:29am	193	11.92	33	5.21
10:30am-10:59am	98	6.05	34	5.37
11:00am-11:29am	116	7.16	67	10.58
11:30am-11:59am	101	6.24	29	4.58
12:00pm-12:29pm	83	5.13	17	2.69
12:30pm-12:59pm	65	4.01	18	2.84
1:00pm-1:29pm	81	5.00	41	6.48
1:30pm-1:59pm	145	8.96	77	12.16
2:00pm-2:29pm	129	7.97	61	9.64
2:30pm-2:59pm	187	11.55	42	6.64
3:00pm-3:29pm	118	7.29	54	8.53
3:30-3:59pm	130	8.03	103	16.27
Total	1619		633	