Impact of Capital Controls and Transaction Costs on the Return Distribution of Dually Traded Securities: Evidence from Chile and Argentina

by

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ABSTRACT

In this paper we compare the distributions of ADR returns and the returns of the locally traded shares between Chile and Argentina. This comparison is interesting because both countries are emerging economies with a similar free market orientation. Both countries have similar free market orientation, but they differ in two important respects: (1) exchange rate regime and (2) restrictions to foreign investments. We find several differences between the two economies. Consistent with previous research, we find that the volatility of ADR returns tends to be higher than the return volatility of the underlying securities. We also find that the return distributions of Chilean ADRs are significantly different from the distributions of the returns on the respective underlying Chilean shares. The results reveal that while the mean returns are the same, the return standard deviations are significantly different. In contrast, Argentinean ADRs and their respective underlying shares tend to have the same distribution of returns. Finally, we employ a threshold model to estimate the transaction cost of trading the ADRs and the locally traded shares. We find that transaction costs that must be added to the returns difference before arbitrage is possible are between 1% and 2% for Chilean ADRs, and slightly lower - 0.66% to 1.65% for Argentinean ADRs. We also find that the daily return differential reversion caused by arbitrage activities is around 30% for Chilean ADRs and 40% for Argentinean ADRs.

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I. Introduction

Over the last three decades many countries have opened their physical and financial markets for foreign investment. This process, labeled in the literature the process of markets globalization, included the easing of various markets restrictions on capital flows from one country to another. During this period, the growth of the market for American Depository Receipts (ADRs) has exploded.

ADRs are negotiable certificates traded in the U.S. financial markets; they simply represent the shares of foreign country firms. American commercial banks serve as the depository units for the ADRs. Thus, although trading ADRs in the U.S. is U.S. dollar denominated, it should be equivalent to trading the foreign firms' shares without actually trading them in their respective local markets.

The market for ADRs has been developed for various reasons most of which are analyzed in the literature. Value maximization, diversification, investor recognition and overcoming market segmentation, to name a few. Price and return reaction to cross market listing, possible arbitrage opportunities and the difference between ADR returns and the returns on their local counterpart shares are some of the issues raised by many researchers. For an excellent review of this growing body of literature see Karolyi (1998).

Most studies on the benefits of cross listing have found a positive stock price reaction as well as a decline in the cost of capital. See Alexander, Eun and Janakiramanan (1987), Domowitz, Glen and Mahavan (1997a), Miller (1998), Jayaraman, Shastri and Tandon (1998) and Forester and Karolyi (1999). Officer and Hoffmeister (1987) and Wahab and Khandwala (1993) found that ADRs present investors with an excellent diversification opportunity, while studies by Maldonado and Saunders (1983), Kato, Linn and Schallheim (1991), Park and Tavakkol (1994), Miller and Morey (1996) and Karolyi and Stulz (1996) concluded that ADRs do not present any arbitrage opportunities. The only study that did find some arbitrage opportunities is by Wahab, Lashgari and Cohn (1992).

In the absence of direct or indirect trading barriers, there should not exist significant differences between the return distribution of locally traded shares and that of the U.S. traded ADR. That is, ADRs and their underlying shares are expected to be perfect substitutes and no arbitrage opportunities should be present. Many researchers write about the issue of international barriers to trading, investments and cash flows movements. Stulz (1981) develops a model of investment with international barriers. Eun and Janakiramanan (1986) describe many of the barriers that existed at that time. More recently, Stulz and Wasserfallen (1995) analyze a case of market segmentation in Switzerland, and Domowitz, Glen and Madhavan (1997b) develop a model of market segmentation based on cash flows restrictions.

Two possible sources of differences between the return of locally traded shares and the ADR returns are transaction costs and the distribution of the foreign exchange rate between the U.S. and the firm's country. If transaction costs in the U.S. market are smaller than those in the local market because of higher liquidity, for example, it is possible that returns will be distributed differently. Also, in order to put both distributions on the same footing, one might translate the local market prices to U.S. dollars. In this case, the distribution of the foreign exchange may influence the behavior of the resulting distribution. Park and Tavakkol (1994) find that returns on Japanese ADRs are not significantly different from the returns on the underlying shares traded in Japan. They also report that the return volatility of ADRs is larger than the underlying shares volatility. They find, however, that this larger volatility is the result of currency return's volatility and the covariance between the stock and the currency returns.

In this paper we compare the distributions of ADR returns and the returns of the locally traded shares between Chile and Argentina. This comparison is interesting because both countries are emerging economies with a similar free market orientation. They differ, however, in two important respects. While Chile maintains its own currency, the Chilean peso (CLP), and still imposes several cash flows restrictions on foreign investments, the Argentinean government has implemented a successful currency board, fixing the Argentinean Peso (ARS) to the U.S. dollar and removing all impediments to foreign investments and cash flow movements. Therefore, an analysis of distributional similarities and differences between their respective ADRs returns and the returns on the locally traded shares may shed some light on the relationship between ADR returns and cash flow restrictions, foreign exchange rates as well as transaction costs.

In the analysis we find several differences between the two economies. Consistent with previous research, we find that the volatility of ADR returns tends to be higher than the return volatility of the underlying securities. We then use the method for testing the simultaneous equality of means and variances suggested by Bradley and Blackwood (1989) and tested with financial data by Owen and Rabinovitch (1999). Here we find the main difference between the returns on stocks in the two countries and the returns on their ADRs. The general finding is that the return distributions of Chilean ADRs are significantly different from the distributions of the returns on the respective underlying Chilean shares. The results reveal that while the mean returns are the same, the return standard deviations are significantly different. As mentioned above, they are larger for the ADR returns than for the returns on locally traded stocks. In contrast, Argentinean ADRs and their respective underlying shares tend to have the same distribution of returns. Finally, we employ a threshold model proposed by Tsay (1989), and implemented by Prakash and Taylor (1998), to estimate the transaction cost of trading the ADRs and the locally traded shares. We find that transaction costs that must be added to the returns difference before arbitrage is possible are between 1% and 2% for Chilean ADRs, and slightly lower - 0.66% to 1.65% for

Argentinean ADRs. We also find that the daily return differential reversion caused by arbitrage activities is around 30% for Chilean ADRs and 40% for Argentinean ADRs.

This paper is organized as follows. Section II introduces the data and presents univariate statistics. Section III compares return distributions based on the tail behavior of the returns, mean returns and return volatility. Section IV estimates the transaction costs implied by a threshold arbitrage model and discusses the impact of capital flow restrictions on arbitrage opportunities and transaction costs. Section V concludes the paper.

II. The Data

The data analyzed in this paper are the daily returns on six locally traded firms from Argentina and fourteen locally traded firms from Chile and their respective NYSE traded ADRs. The sample periods are different for the different firms, depending on the dates that ADRs started trading on these firms on the NYSE. Table 1 presents the data. Notice that in all cases the sample size is relatively. Table 2 exhibits several univariate characteristics of the data. Note that the high kurtosis values in all cases indicates that the returns' distribution is non normal. Also, the extreme values, to be analyzed further in the next section, of the left tail tend to be larger in the ADR market. This occurs in four out of the six cases of the firms from Argentina and eleven out of the fourteen firms from Chile. The right tail extreme values tend to be larger than the left tail extreme values in both the local and the ADR markets. The indication is that the distributions of the returns on the locally traded firms and their corresponding ADRs may differ in the tails.

III. A Comparison of Return Distributions.

In this section we use several statistical tests in order to compare the return distributions of the locally traded stocks and their ADRs across the two countries. Following the last remarks in Section II we begin with an analysis of the distributions tails. We then test for equality of the distributions based on the Kolmogorov – Smirnov (KS) distribution test. This test indicates that in most cases the return distributions for the Argentinean firms are equal across markets, while they are not equal for most Chilean firms. We then test for a joint means and standard deviations of the distributions. Again, the results suggest distribution equality for firms from Argentina. For Chilean firms, the mean returns are equal across markets, but the return standard deviations for ADRs are larger than for locally traded shares.

III.A. The Return Distributions' Tails

Harvey (1995a, 1995b) and Claessens, Dasgupta and Glen (1995) document that stock returns in emerging markets indexes significantly depart from normality. As mentioned above, we confirm this result for individual firms in Table 2. The high excess kurtosis forces a rejection of normality for all the firms in both countries under the traditional Jarque-Bera normality test. This departure from normality is greatly influenced by the behavior of extreme returns. Susmel (2000) argues that the main difference between stock returns in emerging markets and well-established markets is the behavior of the returns on the tails of the distribution, especially on the left tail. We emphasize the latter result because the left tail behavior is probably the most relevant for money managers that have to comply with value-at-risk requirements.

We wish to test the behavior of returns on the ADRs and those on the locally listed shares on their distributions' tails. To estimate the tails of the distributions, we use extreme value theory. Consider the stationary sequence X_1, X_2,..X_n of i.i.d random variables with a distribution function F(.). We wish to find the probability that the maximum of the first n random variables, M_n, is below a certain value x. We denote this probability by $P(M_n<x) = F^n(x)$. M_n could be multiplied by -1 if one is interested in the minimum. The distribution

function $F^n(x)$, when suitably normalized and for large n, converges to a limiting distribution G(x), where G(x) is one of three known asymptotic distributions, see Leadbetter, Lindgren and Rootzen (1983). Since returns on financial assets are fat tailed, Koedijk, Schafgans and De Vries (1990) consider the limiting distribution of G(x) which is characterized by a lack of some higher moments:

$$(1) \qquad G(x) = \exp(-x)^{-1/\alpha} = \exp(-x)^{-\gamma}, \qquad \text{if } x > 0,$$

$$G(x) = 0, \qquad \text{if } x \leq 0.$$

where $\gamma=1/\alpha>0$ and α is the tail index. Leadbetter, Lindgren and Rootzen (1983) show that when the dependence among the X_i's is not too strong, this limiting distribution is valid. The Student-t with finite degrees of freedom, the stable distribution, and the ARCH process are included in the above G(x) distribution. For the Student-t distribution, α is the degrees of freedom. The symmetric stable distribution requires α to be lower than two. The tail index indicates the number of moments that exist.

To estimate γ we use Hill's(1975) moment estimator. We first obtain the order statistics $X_{(n)}$, $X_{(n-1)},\ldots, X_{(1)}$ from the sample, where $X_{(n)}>X_{(n-1)}>\ldots> X_{(1)}$, etc. Then, the Hill estimator is given by:
where m is the number of upper order statistics included. The Hill estimator can be applied to

$$(2)\hat{g} = \frac{1}{m}\sum_{i=1}^{i=m}\ln(X_{n+1-i}) - \ln(X_{n-m}),$$

either tail of a distribution by calculating order statistics from the opposite tail and multiplying the data by -1. It is also possible to combine the tail observations by taking the absolute values in order to estimate a common α. Goldie and Smith (1987) show that $(1/\hat{a} - 1/\alpha)m^{1/2}$ is asymptotically normal N(0,ã^2) if m increases suitably as n tends to infinity. The asymptotic normality of $1/\hat{a}$ makes testing hypotheses about the tails of the distribution relatively easy.

Table 2 presents the estimates of the tails, using (2), along with their standard errors. The last two columns of Table 2 show the right tail estimate, α_+, and the left tail estimate, α_-, respectively. First we note that the estimates for the firms in both countries are quite similar and with few exceptions, the estimates are between 2 and 3. Second, observe that the tails for both the local shares and their corresponding ADRs are symmetric. That is, the magnitudes of the left tail estimates are not significantly different from the magnitudes of the right tail estimates. Thirdly, the local shares do not have significantly different tails than their corresponding ADRs. In conclusion, the results so far, point out that the behavior of extreme values is similar in Chile and Argentina. Moreover, the distributions of the local shares and their corresponding ADRs, in both countries, are not different in the tails.

III.B. The Return Distributions, their Means and Standard Deviations

We begin this section with three non parametric tests whose results are shown in Table 3. The most important result is that, with only one exception, all the three tests – Kolmogorov-Smirnov, (KS) Wilcoxon rank sums (WS) and the value of the Median scores (MS) – fail to reject the null hypothesis for the firms from Argentina. Note that the KS test rejects equality of distributions for only one firm from Argentina, namely, TGS. On the contrary, the KS test rejects equality of return distributions across markets for the 14 Chilean firms. On the other hand, the WS and MS location tests fail to reject the null for most Chilean firms. Thus, the differences found across markets for Chilean firms are related to the dispersion, but not to the location, of the return distributions.

In order to further analyze the return distributions, we now employ the joint test of simultaneous means and variances equality. This test was suggested by Bradley and Blackwood (1989) and applied to financial data by Owen and Rabinovitch (1999). Let $r_{j,}$

$_t$ denote the return on a stock traded in country j, j = Argentina, Chile, and $r_{US,\,t}$ denote the return on the corresponding ADR, t = 1,2,….,T. Assume that the return distributions belong to the elliptical family. For further details, see Owen and Rabinovitch (1999) and the references therein. Next, define $y_t = r_{AR,\,t} - r_{US,\,t}$ and $x_t = r_{AR,\,t} + r_{US,\,t}$. Define $DEVX_t = x_t - \bar{x}$. Then, perform the following regression:

(3) $y_t = \beta_0 + \beta_1 DEVX_t + e_t$.

Regression (3) yields an F value and two t-values. The F value tests the null hypothesis that both the means and the variances are equal simultaneously. If the F-value is large, the Null hypothesis is rejected and the t-values can be used to test the equality of the means and the equality of the variances separately. Table 4 exhibits the results of these regressions. The table indicates the simultaneous equality of the mean returns and the returns variances for the Argentinean firms in all but one case. It also shows the equality of the mean returns for the Chilean firms. But for 9 out of the 14 firms from Chile we see that the volatility of ADR returns is significantly larger than the volatility of the returns on the locally traded shares.

IV. Arbitrage, Transaction Costs and Threshold Models

Arbitrage between two identical assets that trade in two different markets is very easy to implement when transaction costs are ignored. Simply start from an equilibrium situation, in which the prices in the two markets are equal. If during a certain time period, the asset's price in market B becomes higher than the price in market A, arbitrageurs will buy the asset in market A and sell it in market B. Thus, during this time period the asset's prices will adjust by increasing in market A and decreasing in market B until equilibrium is restored. As mentioned above, this traditional description of arbitrage ignores transaction costs.

Accounting for these costs, the price adjustment will occur only if the price differential is larger than the transaction costs faced by arbitrageurs. That is, the price adjustment mechanism is non-linear in nature.

Heuristically, we can apply the above arbitrage mechanism to shares traded in two different markets: the local market and the ADR market. Let y_t represent the difference between the local returns and the ADRs returns and let κ measure the transaction costs faced by arbitrageurs. Suppose that arbitrageurs believe in a long-run arbitrage-free equilibrium between the local shares and the ADRs and assume that on a given day the local returns are larger than the ADR returns by more than the transaction costs associated with trading, i.e., $y_t > \kappa$. Then, arbitrageurs will have the incentive to invest in the ADR market and, therefore, will create a reversion to the long-run equilibrium situation. Under this dynamic behavior, the arbitrage adjustment mechanism between the local and ADR markets can be approximated by Tong's (1983) threshold autoregressive (TAR) model:

(4) $$y_t = \alpha_{out} + \beta_{out}\, y_{t-1} + e_{out,t}, \qquad \text{if } |y_{t-1}| > k,$$

$$y_t = \alpha_{in} + \beta_{in}\, y_{t-1} + e_{in,t}, \qquad \text{if } |y_{t-1}| < \kappa,$$

where β_{out} measures the speed of convergence toward equilibrium. We assume $e_{out,t}$ follows a Normal distribution, $N(0,\sigma^2_{out})$, and $e_{in,t}$ follows a Normal distribution, $N(0,\sigma^2_{in})$. Since daily returns are on average very small, we assume $\alpha_{out} = \alpha_{in} = 0$.

The first equation of model (4) describes the behavior of the returns difference when there are arbitrage opportunities, because the return differential is greater that the transaction costs. Note that arbitrage predicts that β_{out} should be negative. The second equation describes the behavior of the returns difference when there is no arbitrage opportunities. That is, equilibrium without any arbitrage opportunities exists for all y_t values in the interval $[-\kappa,\kappa]$, and not just at the point 0. Thus, inside this interval, there is no autoregressive behavior, which implies β_{in} = 0. Note that the above model assumes that arbitrageurs face symmetric transaction costs.

There are four parameters to estimate β_{out}, σ^2_{out}, σ^2_{in}, κ. Following Fanizza (1990) and Balke and Fomby (1997), we use a best-fit grid search on the threshold parameter κ. Here, we follow Fanizza's (1990) approach to maximize the likelihood function. (Balke and Fomby (1997) minimize the residual sum of squares.) This approach is relatively simple, but simplicity is bought at a price: the parameter κ is not identified under the Null hypothesis of no threshold. Moreover, the likelihood function is discontinuous and not well-behaved, and the use of a grid method to select κ makes it impossible to report standard errors. The grid search is greatly simplified, however, by the implicit assumption in (3) of symmetric transaction costs.

Before estimating model (4), we tested for general nonlinearities in the returns spreads between the local assets and their corresponding ADRs. We use the F-test proposed by Lukkonnen, R., P. Saikkonen, and T. Terarsvirta, (1988), which attempts to detect second-, third-, and fourth-order nonlinearity in an AR model. The last column of Table 5 reports these F-tests, LST-F, and their corresponding p-values. The linearity assumption is strongly rejected in all cases. Based on this strong rejection of the standard AR model, then, we estimate the non-linear model based on (4).

Table 5 also shows the estimates of the above model. The autoreggresive parameter, β_{out}, is significant in all the cases. For the case of the Argentinean firms, the estimates imply a significant next day return differential reversion toward equilibrium of around 40%. Note that the signs are negative as predicted by the arbitrage argument. The transaction costs are estimated to be between 0.66% and 1.63%. For the Chilean firms, the results are also consistent with model (4). The parameter β_{out} is negative and statistically significant. The estimates of the speed of adjustment, for all the cases, are around 30%. The Chilean transaction costs faced by arbitrageurs are estimated to be between .80% and 2%.

IV. A Discussion: Regulatory Time Constraints, Delays and the TAR

Above, we estimate next day return differential reversions for Chilean and Argentinean cross-listed securities. However, for regulatory constrains in Chile, the mechanism involved in exploiting arbitrage opportunities across markets may involve a longer period. Let's analyze the time periods involved in arbitrage operations for Chilean securities. Suppose the USD price of the locally traded stock is higher than the ADR price. Then, the international arbitrageur buys ADRs in the U.S. market and converts them into the underlying share. The custodian bank, representing the foreign investor, reports the ADR conversion to the Chilean central bank and requires approval for: 1.- exchanging into dollars the CLP proceeds from the sale of the shares in the local exchange and 2.- sending the dollar amount to the U.S. The central bank has up to seven days to process the paper work and approve the foreign exchange transaction. Once permission is given, the foreign investor is obliged to send abroad the dollars in a period no longer than five days. According to regulators, this process guaranties that foreign investors enter the local market for arbitrage reasons and not to perform speculative operations.[1] In addition, local investors are not permitted to perform arbitrage operations with ADRs. Table 6 presents a summary of the activities required to perform arbitrage along with the times and transaction costs involved.

Now suppose the USD price of the locally traded share is lower than the ADR price. The arbitrageur is then interested in buying the local shares and converting them into ADRs. In this process, he needs the central bank's approval for entering dollars into Chile. Thus,

[1] Before May 2000, foreign investors entering the Chilean market for speculative reasons were subject to the one-year minimum holding period.

international arbitrage operations are subject to regulatory-induced time delays in both directions.

Given the discussion above, adjustments to return differentials across markets may take place in more than one trading day. Therefore, we might be underestimating the speed of adjustment in (4). Observe in table 7 how some autocorrelations for the return difference series are significant beyond lag one. In order to accommodate price adjustment delays for regulatory time constraints in Chile, we may need to introduce longer memory to the TAR(p;n,d) model, by varying the autoregressive parameter, p, and the delay parameter, d (the number of thresholds, n, is equal to 1 in our model). We may need to introduce returns accumulated over a period of days. These extensions complicates the TAR estimation.

V. Conclusions

Over the last three decades many countries have opened their physical and financial markets for foreign investment. During this period, the growth of the market for American Depository Receipts (ADRs) has exploded. In this paper we compare the distributions of ADR returns and the returns of the locally traded shares between Chile and Argentina. This comparison is interesting because both countries are emerging economies with a similar free market orientation. They differ, however, in two important respects. While Chile maintains its own currency, the Chilean peso (CLP), and still imposes several cash flows restrictions on foreign investments, the Argentinean government has implemented a successful currency board, fixing the Argentinean Peso (ARS) to the U.S. dollar and removing all impediments to foreign investments and cash flow movements. In the analysis we find several differences between the two economies. Consistent with previous research, we find that the volatility of ADR returns tends to be higher than the return volatility of the underlying securities. We also find that the return distributions of Chilean ADRs are significantly different from the distributions of the returns on the respective underlying Chilean shares. The results reveal that while the mean returns are the same, the return standard deviations are significantly different. In contrast, Argentinean ADRs and their respective underlying shares tend to have the same distribution of returns. Finally, we employ a threshold model proposed by Tsay (1989), and implemented by Prakash and Taylor (1998), to estimate the transaction cost of trading the ADRs and the locally traded shares. We find that transaction costs that must be added to the returns difference before arbitrage is possible are between 1% and 2% for Chilean ADRs, and slightly lower - 0.66% to 1.65% for Argentinean ADRs. We also find that the daily return differential reversion caused by arbitrage activities is around 30% for Chilean ADRs and 40% for Argentinean ADRs.

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TABLE 1. DATA DESCRIPTION

Firm	Ticker symbol	Industry	Sample: Start of ADR trading-end	Market Cap. (USD million)	ADR Daily Volume (USD)	Local Daily Volume
ARGENTINA						
Banco Frances	BFR	Banking	11/24/93-5/24/00	1,340	175,275	467,910
Banco Rio de la Plata	BRS	Banking	10/10/97-5/24/00	2,380	53,300	46,494
YPF S.A.	YPF	Oil & Gas Operator	07/07/93-5/24/00	12,200	760,912	69,240
Telefonica de Argentina	TAR	Telecommunication	03/08/94-5/24/00	7,680	752,675	78,220
Telecom Argentina STET	TEO	Telecommunication	12/09/94-5/24/00	2,180	2,500,506	3,430,048
Transportadora de Gas S.A.	TGS	Gas & Oil Operation	11/17/94-5/24/00	1240	383,500	96,316
CHILE						
Compañia Cervecerias	CU	Beverages	09/28/93-12/30/96	1,430	46,000	290,883
Viña Concha y Toro	VCO	Alcoholic beverage	10/17/94-04/13/99	535.8	3,000	76,480
Cristalerias de Chile	CGW	Glass products	04/13/90-04/13/99	369.3	13,000	224,958
Compañia de Telecom. de Chile	CTC	Telecommunication	07/23/90-04/13/99	4,410	395,000	1,775,235
Banco de A. Edwards	AED	Banking	11/06/95-04/13/99	493.4	64,000	216,570
Empresa Nac. Elec. (ENDESA)	EOC	Energy	07/28/94-04/13/99	3,200	142,000	3,103,186
Enersis S.A.	ENI	Electric utility	10/21/93-04/13/99	2960	62,000	2,857,560
Laboratorio Chile S.A.	LBC	Biothech	07/01/94-04/13/99	307.1	55,000	236,467
Madeco S.A.	MAD	Misc. Fabric. Prods.	06/01/93-04/13/99	299.1	59,000	156,033
Masisa S.A.	MYS	Constr. Supplies	06/18/93-04/13/99	353.7	95,000	247,357
Administradora Fondos Provida	PVD	Insurance	4/17/94-04/13/99	5410	98,000	112,439
Banco Santander Chile	BSB	Banking	11/15/94-04/13/99	1,720	328,000	225,613
Soc. Quimica y Minera de Chile	SQM	Chemical Industry	09/22/93-04/13/99	278.4	16,000	659,501
Santa Isabel	ISA	Retail (grocery)	08/01/95-04/13/99	195.2	28,000	259,095

Notes:
Market Cap: Market Capitalization calculated at May 24, 2000.

TABLE 2. UNIVARIATE RESULTS

Summary statistics for daily returns on locally traded stocks (L) and their NYSE ADRs (A). The calculated statistics are the mean, the standard deviation (SD), skewness coefficient (Skew), excess kurtosis (Kurt), maximum, fifth largest observation (max5), fifth lowest observation (min1), minimum, right tail (α_+), and left tail (α_-).

Ticker		mean	SD	Skew	Kurt	max1	max5	min5	min1	α_+	α_-
ARGENTINA											
BFR	L	.0151	3.142	0.445	6.962	27.764	11.821	-11.551	-16.246	3.739 (.44)#	2.303 (.23)
	A	-.0098	3.202	0.211	5.686	21.401	11.957	-12.411	-19.083	2.447 (.25)	2.614 (.46)
BRS	L	-.0425	3.265	-0.494	5.976	15.749	9.531	-12.629	-17.451	2.298 (.38)	2.139 (.44)
	A	-.0384	3.477	-0.205	7.707	22.314	11.249	-11.912	-21.622	2.250 (.39)	3.327 (.76)
YPF	L	.0428	2.041	0.329	7.299	15.864	9.215	-8.613	-12.613	2.521 (.30)	2.497 (.25)#
	A	.0337	2.110	0.219	6.337	15.141	9.531	-9.171	-12.143	2.058 (.19)	2.045 (.19)
TAR	L	.0268	2.900	0.718	7.666	23.333	13.976	-10.629	-16.161	2.878 (.30)#	2.852 (.30)#
	A	.0255	2.948	-0.386	15.94	25.489	15.534	-9.704	-30.619	2.699 (.24)#	2.813 (.27)#
TEO	L	-.0075	2.871	0.305	5.347	19.957	13.249	-10.500	-16.352	3.302 (.50)#	2.517# (.24)
	A	.0089	2.876	-0.012	4.889	18.999	12.527	-8.701	-17.638	2.605 (.31)	2.675 (.25)#
TGS	L	.0214	2.267	-0.298	8.575	13.946	9.109	-8.516	-16.115	2.424 (.31)	2.645 (.61)
	A	.0266	2.292	-0.105	8.625	14.974	9.379	-8.311	-19.498	2.614 (.29)#	2.608 (.28)#
CHILE											
CU	L	0.048	2.139	0.909	10.261	14.835	9.589	-7.500	-12.289	2.215 (.31)	2.306 (.37)
	A	0.049	2.259	1.006	8.108	14.286	12.069	-8.065	-11.856	2.767 (.40)	2.121 (.20)
VCO	L	0.085	1.920	0.617	6.648	11.554	8.527	-6.081	-8.996	2.134 (.29)	2.172 (.29)
	A	0.068	2.143	0.2513	3.737	12.346	8.152	-7.910	-9.848	3.129 (.52)#	3.113 (51)#
CGW	L	-0.018	2.180	0.560	10.348	16.818	7.234	-8.297	-12.037	2.602 (.34)	2.638 (.38)#
	A	-0.053	2.388	0.5426	8.794	20.588	8.451	-8.511	-11.236	2.713 (.43)	2.656 (.44)
CTC	L	0.132	1.909	0.556	7.373	16.352	8.899	-7.809	-13.006	2.871 (.29)	2.845 (.25)#
	A	0.106	2.064	0.376	8.584	17.731	9.804	-8.295	-13.548	2.359 (.20)	2.185 (.21)
AED	L	-0.013	2.387	0.564	10.66	17.647	10.000	-9.343	-13.830	2.026 (.27)	1.688 (.18)
	A	-0.013	2.598	-0.324	11.22	14.130	10.370	-10.256	-20.896	2.148 (.28)	2.157 (.45)
EOC	L	-0.010	1.879	1.060	8.855	17.647	7.422	-6.061	-7.143	3.017 (.38)#	3.362 (.46)#
	A	-0.023	2.151	0.654	4.154	15.663	8.036	-7.059	-8.824	3.333 (.48)#	3.189 (.60)#
ENI	L	0.041	2.035	0.678	4.529	14.894	8.000	-6.906	-8.333	3.747 (.50)#	2.874 (.29)#
	A	0.030	2.302	-.0593	6.235	13.740	8.671	-8.125	-18.443	2.735 (.43)	2.721 (.39)#
LBC	L	0.0691	2.334	0.410	4.319	13.462	9.091	-7.813	-12.152	2.621 (.37)	2.598 (.34)
	A	0.0638	2.5138	0.509	7.87	18.333	10.377	-9.783	-15.190	2.267 (.25)	2.247 (.27)
MAD	L	0.0003	2.6728	-0.437	10.056	17.682	9.259	-13.043	-19.318	2.293 (.28)	3.696 (1.39)
	A	-0.018	2.834	0.436	17.768	29.655	10.007	-11.286	-22.321	1.928 (.21)	2.582 (.54)
MYS	L	-0.007	2.5524	0.759	6.897	18.750	10.811	-9.722	-11.765	2.652 (.26)	2.609 (.25)#
	A	-0.016	2.7226	0.647	8.718	22.581	11.404	-9.780	-18.182	2.343 (.21)	2.369 (.23)#
PVD	L	0.0433	2.121	0.2193	12.631	15.517	6.765	-7.500	-14.706	1.961 (.29)	2.140 (.29)
	A	0.0222	2.0927	0.236	2.933	10.494	7.273	-6.406	-9.821	2.085 (.20)	2.079 (.21)
BSB	L	0.0572	2.4335	0.014	12.963	18.182	9.677	-9.091	-19.149	2.116 (.31)	2.143 (.62)
	A	0.0538	2.749	-0.115	11.152	17.647	11.111	-11.215	-22.283	2.156 (.29)	2.284 (.35)
SQM	L	-0.001	2.0333	-0.571	7.666	10.536	7.131	-9.343	-17.237	2.335 (.23)	2.774 (.37)#
	A	-0.001	2.0267	-0.520	7.496	11.350	7.379	-9.685	-17.907	2.103 (.20)	2.434 (.28)
ISA	L	0.0270	2.3782	-0.274	8.778	12.245	8.597	-7.563	-15.349	2.139 (.22)	2.065 (.22)
	A	-0.001	2.8815	-0.914	19.046	16.260	12.503	-10.373	-28.358	1.879 (.24)	1.878 (.24)

Notes: #: significantly different from 2.

α_+: right tail estimate

α_-: left tail estimate

TABLE 3. NON PARAMETRIC TWO-SAMPLE TESTS

Comparisons of daily return distributions for locally traded stocks and their NYSE ADRs. The value for the Kolmogorov-Smirnov statistic is KS and the asymptotic statistic is KSa (p-value in parenthesis). The value of the Wilcoxon Ranks Sums test is WS and its Z score WZ (p-value in parenthesis). The value of the Median Scores test is MS and its Z score MZ (p-value in parenthesis).

Ticker	Kolmogorov-Smirnov test		Wilcoxon Rank Sums test		Median Scores (Number of Points Above Median) test	
	KS	KSa	WS	WZ	MS	MZ
ARGENTINA						
BFR	0.0200	0.707 (0.699)	390789	-.02328 (0.981)	306.777	-0.6767 (0.497)
BRS	.0107	.5954 (0.870)	2368066	0.3256 (0.745)	771.052	0.2280 (0.8196)
YPF	0.0166	0.9563 (0.320)	2747518	0.3997 (0.6894)	834.465	0.5426 (0.5874)
TAR	0.01631	0.0326 (0.416)	2161940	0.3331 (0.739)	740.476	0.5261 (0.599)
TEO	0.01266	0.02532 (0.783)	1809087	0.2372 (0.813)	675.289	0.3008 (0.764)
TGS	0.0313	1.5812 (0.014)*	1638493	-0.02935 (0.977)	634.264	-0.5034 (0.615)
CHILE						
CU	0.0427	2.3403* (0.0001)	2093880	0.7270 (0.4672)	701.869	0.7575 (0.4487)
VCO	0.0515	2.2661* (0.0001)	805584	0.3246 (0.7455)	431.000	1.6154 (0.1062)
CGW	0.0849	3.8184* (0.0001)	768740	1.8665 (0.0620)	363.664	-.4371 (0.6620)
CTC	0.0282	1.7799* (0.0035)	3622507	-.6919 (0.4890)	920.398	0.3025 (0.7623)
AED	0.0669	2.6833* (0.0001)	627422	0.7720 (0.4401)	368.000	-1.7923 (0.0731)
EOC	0.0465	2.2212* (0.0001)	1294676	0.5215 (0.6020)	540.000	-2.0016* (0.0453)
ENI	0.0266	1.3702* (0.0468)	1747092	0.0730 (0.9418)	627.000	-2.3383* (0.0194)
LBC	0.0639	3.0537* (0.0001)	1283095	0.6583 (0.5103)	573.000	1.4575 (0.1450)
MAD	0.0660	3.3619* (0.0001)	1538042	1.8493 (0.0644)	577.681	-.0495 (0.9605)
MYS	0.0578	2.9912* (0.0001)	1689726	0.8049 (0.4209)	598.750	-2.0635* (0.0391)
PVD	0.0635	2.7361* (0.0001)	740052	1.5879 (0.1123)	405.532	1.6611 (0.0967)
BSB	0.0669	2.9420* (0.0001)	829133	0.8289 (0.4071)	434.000	1.0492 (0.2941)
SQM	0.0271	1.4030* (0.0390)	1761579	0.2736 (0.7844)	656.510	0.0406 (0.9676)
ISA	0.0778	3.1600* (0.0001)	626192	1.0838 (0.2784)	385.000	1.3083 (0.1908)

Notes:

- * significant at the 5% level.

TABLE 4. MEAN-VARIANCE RESULTS

This table presents parameter estimates and test statistics for the equality tests. The regression coefficients are for the following joint means and variances equality test:

$y_t = \beta_0 + \beta_1$ DEVX$_t + e_t$

$y_t = r_{J,t} - r_{US,t}$

$x_t = r_{J,t} + r_{US,t}$

DEVX$_t = x_t - \overline{X}$

J = Argentina, Chile

Ticker	Equality test		
	constant	DEVX$_t$	F-test
ARGENTINA			
BFR	-0.025 (0.51)	-0.0103 (-1.29)	0.958
BRS	-0.007 (0.11)	-0.033 (3.36)*	5.625*
YPF	-0.013 (0.15)	-0.329 (1.40)	0.984
TAR	0.001 (0.02)	-0.010 (0.79)	0.309
TEO	0.016 (.46)	-0.001 (.15)	0.344
TGS	-0.005 (0.09)	-0.006 (-0.50)	0.128
CHILE			
CU	0.00027 (0.61)	-0.35342 (-3.27) *	5.348 *
VCO	-0.00005 (-0.08)	-0.04399 (-2.25) *	2.538 *
CGW	0.00034 (0.50)	-0.00395 (-0.22)	0.025
CTC	0.00010 (0.33)	-0.03696 (-4.66) *	10.839 *
AED	-0.00051 (-0.64)	0.02299 (1.15)	0.667
EOC	0.000009 (0.02)	-0.05461 (-5.33) *	14.226 *
ENI	0.00021 (0.53)	-0.04823 (-5.24) *	13.729 *
LBC	0.00019 (0.32)	-0.03015 (-2.31) *	2.678 *
MAD	0.00005 (0.07)	0.00421 (0.28)	0.039
MYS	-0.00016 (-0.27)	-0.02305 (-1.86)	1.736
PVD	0.00097 (1.36)	-0.00919 (-0.44)	0.096
BSB	0.00051 (0.71)	-0.04745 (-2.48) *	3.079 *
SQM	-0.00012 (-0.31)	0.02546 (2.65) *	3.524 *
ISA	-0.00058 (-0.71)	-0.06303(-3.14) *	4.943 *

Notes:

* significant at the 5% level.

TABLE 5. ESTIMATION OF TRANSACTION COSTS

This table estimates the transaction costs of opening opposite positions in the locally traded shares and their ADRs, based on the following model:

$$y_t = \alpha_{out} + \beta_{out}\, y_{t-1} + e_{out,t}, \qquad \text{if } |y_{t-1}| > \kappa$$
$$y_t = \alpha_{in} + \beta_{in}\, y_{t-1} + e_{in,t}, \qquad \text{if } |y_{t-1}| \quad \kappa$$
$$y_t = r_{J,t} - r_{US,t}$$
$$e_{out,t} \sim N(0,\sigma^2_{out}),\; e_{in,t} \sim N(0,\sigma^2_{in}).$$
J = Argentina, Chile

Ticker	β_{out}	σ^2_{in}	σ^2_{out}	κ	Likelihood	# Obs. out	LST-F
ARGENTINA							
BFR	-0.371 (.03)	1.169 (.03)	2.283 (.06)	0.84	2889.4	711 (46%)	19.18 (0.000)
BRS	-0.489 (.04)	1.190 (.05)	1.611 (.06)	0.69	1095.9	348 (56%)	8.195 (0.000)
YPF	-0.427 (.03)	1.681 (.04)	3.177 (.09)	1.63	3548.1	548 (33%)	13.40 (0.000)
TAR	-0.419 (.04)	1.457 (.03)	3.869 (.13)	1.59	3042.3	425 (29%)	22.05 (0.000)
TEO	-0.438 (.04)	0.958 (.03)	1.400 (.09)	0.66	2087.6	639 (48%)	16.44 (0.000)
TGS	-.370 (.03)	1.589 (.04)	2.231 (.07)	1.41	2675.3	486 (38%)	18.31 (0.000)
CHILE							
CU	-0.343 (.03)	1.326 (.04)	1.501 (.05)	0.82	1758.1	530 (53%)	6.82 (0.000)
VCO	-0.238 (.04)	1.73 (.05)	2.37 (.10)	1.98	1916.9	240 (26%)	5.47 (0.000)
CGW	-0.244 (.05)	1.606 (.04)	2.650 (.13)	1.76	1849.5	225 (24%)	8.44 (0.000)
CTC	-0.269 (.03)	1.062 (.02)	1.612 (.04)	0.87	3439.9	765 (36%)	9.61 (0.000)
AED	-0.332 (.05)	1.530 (.05)	3.398 (.15)	1.47	1645.1	233 (29%)	14.72 (0.000)
EOC	-0.334 (.04)	1.040 (.03)	1.597 (.07)	1.31	1758.1	272 (24%)	14.67 (0.000)
ENI	-0.359 (.04)	1.124 (.02)	1.692 (.07)	1.40	2142.9	286 (22%)	9.61 (0.000)
LBC	-.340 (.04)	1.657 (.04)	3.190 (.11)	1.99	2266.7	268 (24%)	8.17 (0.000)
MAD	-0.310 (.03)	1.716 (.04)	2.356 (.07)	1.70	2679.0	355 (28%)	19.46 (0.000)
MYS	-0.310 (.03)	1.716 (.04)	2.356 (.12)	1.46	2757.6	525 (40%)	13.86 (0.000)
PVD	-0.303 (.05)	1.578 (.04)	2.697 (.12)	1.74	1794.4	253 (28%)	14.12 (0.000)
BSB	-0.303 (.04)	1.613 (.05)	2.654 (.09)	1.02	1988.8	456 (49%)	10.83 (0.000)
SQM	-0.312 (.03)	1.108 (.03)	1.491 (.04)	0.90	2704.8	645 (39%)	13.08 (0.000)
ISA	-0.313 (.05)	1.771 (.05)	3.450 (.12)	0.87	1690.3	206 (26%)	29.28 (0.000)

Notes:
Obs. out: Number of observations outside the threshold.
LST-F: Lukkonnen, Saikkonen, and Terarsvirta's (1988) nonlinear F-test (p-value in parenthesis).

TABLE 6. AUTOCORRELATIONS FOR THE RETURN DIFFERENCE SERIES

This table presents autocorrelations for the return difference between locally traded shares and their NYSE-traded ADRs (t-values are presented in parenthesis).

FIRM	AUTOCORRELATION LAG									
	1	2	3	4	5	6	7	8	9	10
CU	-0.285 (-10.323) *	-0.083 (-2.779) *	0.027 (0.909)	-0.043 (-1.447)	0.016 (0.533)	0.047 (1.585)	-0.038 (-1.264)	-0.011 (-0.359)	0.056 (1.868)	-0.059 (-1.949)
VCO	-0.235 (-6.624) *	-0.068 (-1.810)	0.044 (1.164)	-0.149 (-3.967) *	0.103 (2.689) *	-0.057 (-1.468)	0.001 (0.037)	0.037 (0.950)	-0.078 (-2.018) *	0.049 (1.250)
CGW	-0.154 (-4.117) *	-0.171 (-4.487) *	0.038 (0.980)	-0.094 (-2.393) *	-0.030 (-0.758)	0.035 (0.879)	0.094 (2.371) *	-0.071 (-1.780)	0.008 (0.193)	0.075 (1.869)
CTC	-0.366 (-15.280) *	-0.074 (-2.733) *	0.025 (0.921)	-0.030 (-1.107)	0.016 (-0.577)	0.001 (0.035)	-0.008 (-0.295)	-0.003 (-0.123)	0.013 (0.490)	-0.009 (-0.344)
AED	-0.252 (-6.831) *	-0.070 (-1.788)	0.017 (0.441)	-0.034 (-0.852)	0.040 (1.015)	-0.005 (-0.120)	-0.024 (-0.613)	-0.088 (-2.236) *	-0.043 (-1.072)	0.098 (2.465) *
EOC	-0.328 (-10.749) *	-0.108 (-3.198) *	0.011 (0.317)	-0.060 (-1.765)	0.044 (1.278)	-0.042 (-1.236)	0.025 (0.730)	0.005 (0.132)	0.014 (0.416)	-0.010 (-0.280)
ENI	-0.350 (-12.347) *	-0.069 (-2.189) *	-0.092 (-2.908) *	0.044 (1.377)	0.015 (0.047)	-0.023 (-0.708)	0.020 (0.063)	-0.004 (-0.123)	-0.002 (-0.050)	0.014 (0.451)
LBC	-0.277 (-9.026) *	-0.133 (-4.030) *	-0.036 (-1.072)	-0.003 (-0.082)	0.004 (0.129)	-0.019 (-0.580)	0.004 (0.113)	-0.013 (-0.377)	0.034 (1.086)	-0.027 (-0.803)
MAD	-0.306 (-10.142) *	-0.006 (-0.196)	-0.121 (-3.687) *	0.020 (0.611)	-0.018 (-0.534)	-0.019 (-0.582)	0.036 (1.093)	0.003 (0.096)	0.075 (2.258) *	-0.122 (-3.655) *
MYS	-0.304 (10.521) *	-0.027 (-0.871)	-0.036 (-1.152)	-0.035 (-1.099)	0.052 (1.649)	-0.047 (-1.498)	0.033 (1.055)	0.003 (0.083)	-0.0100 (-3.160)	0.076 (2.375) *
PVD	-0.230 (-6.248) *	-0.061 (1.580)	-0.051 (-1.315)	0.018 (0.454)	-0.035 (-0.888)	0.022 (0.560)	-0.065 (-1.679)	-0.017 (-0.440)	-0.010 (-0.258)	0.029 (0.748)
BSB	-0.297 (-8.454) *	-0.099 (-2.596) *	-0.016 (-0.407)	-0.020 (-0.512)	-0.016 (-0.409)	0.015 (0.388)	0.037 (0.952)	-0.003 (-0.076)	-0.046 (-1.187)	0.023 (0.605)
SQM	-0.313 (-11.077) *	-0.083 (-2.690) *	0.024 (0.772)	-0.031 (-0.990)	-0.001 (0.022)	0.021 (0.667)	-0.033 (-1.070)	0.037 (1.182)	0.041 (1.303)	-0.080 (-2.555) *
ISA	-0.171 (-4.564) *	-0.046 (-1.203)	-0.106 (-2.739) *	0.061 (1.550)	-0.021 (-0.548)	-0.086 (-2.203) *	0.073 (1.854)	0.029 (0.737)	0.048 (1.209)	-0.092 (-2.305) *

TABLE 7. ARBITRAGE ACTIVITIES FOR CHILEAN FIRMS

This table summarizes the activities involved in arbitrage operations for Chilean firms. Transaction costs are approximate and vary according to the agent performing arbitrage and the time period.

USD PRICE OF LOCAL SHARE LOWER THAN ADR PRICE			
	ACTION	**TIME**	**TRANSACTION COST**
1	Inflow of dollars into Chile and conversion into CLP (approval by Central Bank)	up to T+7	½spread + commission at FX market (1%)
2	Buy shares at local exchange	T+2	½spread + commission at local exchange (1.5%)
3	Convert shares into ADRs	?	fee to custodian bank
4	Sell ADRs at NYSE	T+2 ?	½spread + commission at NYSE (0. 5%)
ADR PRICE LOWER THAN USD PRICE OF LOCAL SHARE			
	ACTION	**TIME**	**TRANSACTION COST**
1	Buy NYSE ADR	T+2	½spread + commission at NYSE (0.5%)
2	Convert ADR into shares		fee to custodian bank
3	Sell shares at local exchange	T+2	½spread + commission at lo cal exchange (1.5%)
4	Convert CLP into USD and dollar outflow (requires Central Bank's approval)	up to T+7	½spread + commission at FX market (1%)

TABLE 8. CHRONOLOGY OF MAIN CHANGES IN CHILEAN CAPITAL CONTROLS

1991 June	• Unremunerated reserve requirement (URR) of 20% on foreign loans • Minimum holding period of between 3 and 12 months on foreign loans
1992	
January	• URR is extended to local deposits denominated in a foreign currency
May	• Minimum holding period of one year for all types of foreign investment except ADRs
August	• URR is increased to 30% and extended to all types of foreign investment
1995	
July	• URR is extended to secondary ADRs
December	• Foreign loans used abroad are exempted from the URR
1996 December	• Foreign loans for amounts smaller than USD200,000 are exempted from URR (maximum of USD500,000 per year)
1997 March	• Foreign loans for amounts smaller than USD100,000 are exempted from URR (maximum of USD100,00 per year)
1998	
June	• URR is reduced to 10%
August	• URR for secondary ADRs is eliminated
September	• URR is reduced to 0% (not eliminated)
2000 May	• Minimum holding period for foreign investments is eliminated