Journal of Applied Finance & Banking, vol. 2, no. 6, 2012, 201-215
ISSN: 1792-6580 (print version), 1792-6599 (online)
Scienpress Ltd, 2012

The Effect of International Cross-listings on Stock Risk

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Abstract

In the context of capital market integration, a sample of 64 US firms is examined for any evidence of changes in stock risk as a result of international listings. Several risk measures are tested. Although we are not able to reject the hypothesis that domestic market betas do not change as a result of international listings, we find statistically significant evidence that cross-listings are associated with increases in foreign beta values. This means that sensitivity of stock returns to the common factors of the cross-listed countries increases, suggesting a decreasing effect of international listings on segmentation. Total risk of stocks are found to increase after cross-listings, consistent with the premise that increased information, trading volume, time and number of informed traders as a result of international listings increase the variance of stock returns. Overall, these results suggest evidence of capital market segmentation, rather than integration.

JEL Classification: F36, P45, G32
Key words: Cross-listing, stock risk, capital market integration, capital market segmentation.

1 Introduction

Are international capital markets integrated or segmented? The answer to this question has crucial implications on pricing assets in both national and international context. If international capital markets are perfectly integrated, assets with the same risk should have the same expected return throughout the world. If markets are segmented, having the same risk would not command an identical expected return because of the differing (or no) exposures to world market portfolio.

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Article Info: *Received :* September 9, 2012. *Revised :* October 17, 2012.
Published online : December 20, 2012

Tests of asset pricing theories such as the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965) and Black (1972) assume completely segmented markets for a specific country. On the other hand, attempts to formulate an international asset pricing theory; such as the international arbitrage pricing theory of Solnik (1983) and the world multi-beta model of Ferson and Harvey (1993, 1994) assume complete world market integration. Between these models are the approaches assuming neither a full segmentation nor a complete integration. Errunza and Losq (1985), for instance, propose an international CAPM under mild segmentation.

The evidence on whether international markets are integrated or segmented is mixed. Hypothesizing that if capital markets are either completely or mildly segmented, then international listings should have a decreasing effect on the expected return of common stocks, Alexander, Eun and Janakiramanan (1988) find supporting evidence on segmentation for non-Canadian stocks. Evidence on segmentation was found in other studies as well, such as Foerster and Karolyi (1993, 1999), Jorion and Schwartz (1986) and Mittoo (1992). Bodurtha (1989)[2] and Howe and Madura (1990), on the other hand, find evidence of integration, while Alexander, Eun and Janakiramanan (1988) find evidence of integration for Canadian stocks. Finally, Campbell and Hamao (1992) find evidence suggestive of integration of U.S. and Japanese stock markets.

Studies on integration and segmentation generally assume a static regime on the segmentation or integration side. Contrary to such studies and considering that the integration phenomenon is a dynamic time-dependent process, Bekaert and Harvey (1995) propose a methodology allowing the degree of market integration to change through time. They find that some countries appear more integrated and some others more segmented than one might expect based on prior knowledge of investment restrictions or free access to capital markets. Contrary to the perception that world capital markets have become more integrated, their country-specific investigation suggests that this is not always the case.

Segmentation of capital markets may result from barriers to capital flows, such as legal restrictions, transaction costs and information costs (Alexander, Eun and Janakiramanan, 1987) or individual's attitudes and irrationality (Gultekin, Gultekin and Penati, 1989), which lead to certain corporate incentives to overcome such barriers. One such incentive was proposed by Stapleton and Subrahmanyam (1977), who argue that dual listing of the firm's securities on foreign capital markets can reduce the effects of segmentation.

This paper approaches the integration-segmentation question from the viewpoint of Howe and Madura (1990). They investigate the effects of international listings on certain risk characteristics of stocks by arguing that if markets are segmented and international listings decrease segmentation, then these listings should have an impact on risk.

The paper is organized as follows: Section-2 reviews the literature from both theoretical and empirical perspectives. Data and methodology are described in Section-3. Section-4 presents and interprets the test results and Section-5 concludes.

[2] Bodurtha rejects market integration hypothesis when factor pricing constraints are imposed. However, when such constraints are relaxed, integration is rejected only in the 1973-1977 period.

2 Literature Review

Theory

Theoretical foundations of the effect of international listings on stock characteristics are based on the studies of international capital market integration and segmentation. Segmentation or the lack of integration of capital markets due to the existence of capital flow barriers lead to incentives to circumvent such barriers so as to benefit from diversification opportunities, increased liquidity and investor base, which can manifest themselves with international listings.

Contributions to the theoretical foundations of capital market integration and segmentation include Stapleton and Subrahmanyam (1977), Stulz (1981), Errunza and Losq (1985), Alexander, Eun and Janakiramanan (1987) and Basak (1996). Stapleton and Subrahmanyam (1977) illustrate in a hypothetical eight-firm twenty-investor economy equally divided in two countries that capital market segmentation depress security prices in most cases and creates corporate incentives for diversification through mainly three ways: (i) foreign portfolio/direct investment by firms, (ii) mergers with foreign firms and (iii) dual listing of the securities of the firm on foreign capital markets. In this respect, international listings of a security should have an increasing effect on the price of the security.

Stulz (1981) develops a model of international asset pricing, assuming that markets are fully integrated. He is motivated by the idea that it is not possible to test whether markets are internationally segmented or not without a model which assumes complete integration. Contrary to the then existing international asset pricing models, which assume identical consumption opportunity sets across countries, his model is compatible with differing consumption opportunity sets. He argues that although previous tests are not able to reject the segmented market hypothesis, there is also the possibility that this inability can be attributed to the models used in these tests, which are insufficient in pricing assets in a complete integration setting. According to his model, which assumes complete integration, international listings should have no effect on the systematic risk of stocks.

Errunza and Losq (1985) derive an asset pricing model under conditions of market segmentation and empirically test it, finding supportive evidence in favor of market segmentation. They utilize an "unequal access assumption" to represent segmentation, in which a subset of investing population can trade all available securities while some others are restricted from such trading. The risk-return trade-off that their model yields for segmented markets commands a "super" risk premium for the restricted securities. This implies that if international listings decrease segmentation then they should have a decreasing effect on the "super" risk premium, thereby decreasing the expected return of the security, which implies lower risk.

While Stapleton and Subrahmanyam (1977) propose numerical solutions for the pricing of dually listed securities, Alexander, Eun and Janakiramanan (1987) obtain a closed form pricing relationships under dual listing. According to their model, the change in the required return as a result of dual listing depends on three factors: relative aggregate-risk aversions, market capitalization in the two countries and the covariances of the dually listed security with the domestic and foreign market portfolios. Assuming that risk aversion coefficients are equal, then if the covariance of the return of the dually listed stock with the foreign market index is lower than that of with the local market index, the required return would be lower after dual listing. Since, it is generally the case that stock

returns are less correlated with foreign markets than with domestic markets, their model anticipates a decline in the required rate of return after dual listing.

Basak's (1996) model yield different results than the above mentioned studies regarding the pricing effects of segmentation and integration. He incorporates intertemporal consumption behavior in his model, which yields an increase in the international interest rates as a response to integration. This is due to the decreasing effect of diversification as a result of integration on the riskiness of future consumption, which in turn increases demand for consumption. Given the initial supply of consumption goods is fixed, the result is increased interest rates. The change in interest rates also changes the asset pricing comparisons of segmentation and integration effects. Specifically, while the above theoretical literature generally predicts a decline in the price of restricted securities, Basak's model predicts either an increase or a decrease in security prices depending on the extent of lost diversification opportunities as a result of segmentation and the attractiveness of the security. Then, if his model is correct, the impact of international listings on stock prices and expected returns should be ambiguous.

To consolidate, if international listings decrease segmentation, decrease investment barriers and thus increase investor base by increasing the number of investors and trading hours, it is theoretically expected that liquidity should increase, which should have a positive effect on prices, and expected returns and cost of capital should decrease. Theoretical foundations for the effects on total risk are two sided. Foerster and Karolyi (1993) propose that, if international capital markets are not perfectly correlated, total risk should decrease because of the diversification effect after international listings, as exposures to domestic market decrease and exposures to foreign markets increase as a result of cross-listings. The models of Kyle(1985) and Admati and Pfleifelder (1988), on the other hand, imply increased return variance, mainly as a result of increased information, trading volume, time and number of informed traders. Another possibility proposed by Jayaraman, Shastri and Tandon (1993) is that after the cross listing the return generating process may change from a single-factor model to a two-factor model (the domestic and foreign factors), which in turn has an effect on volatility.

Finally, the effect on stock beta depends on several factors. Since beta is given as:

$$\beta_i=(\rho_{iM}\sigma_i)/\sigma_M$$

where, ρ_{iM} is the correlation of the stock return with the market return, σ_i is the volatility of the stock return, namely the total risk of the stock, and σ_M is the volatility of market index return. σ_M should be irresponsive to the international listing of a stock, while σ_i can either decrease or increase, as discussed above. ρ_{iM} is expected to decrease when a stock cross-lists in a foreign market, because while a new exposure (the foreign market) kicks in, the domestic market exposure should relatively decrease. Therefore, the overall effect on beta depends on the direction and the degree of change in the total risk. If total risk decreases, beta should decrease, if total risk increases, beta should either not change or should slightly increase provided that the increase in total risk is greater than the decrease in ρ_{iM}.

Empirical Evidence

Literature on the empirical evidence of the effects of international listings can be examined in different dimensions of two groups, as the effects differ depending on the specific group and dimension. The first group is stock characteristics, having four dimensions: price, return, risk and liquidity. The second group is the country of listing,

with two dimensions, namely, foreign stocks listed in the US and US stocks listed overseas. This paper concerns the effects of overseas listing of US stocks on stock risk. Therefore, the literature on these effects will be surveyed in more detail.

Before going into detail, however, the effects of international listings on the other stock characteristics –price, return and liquidity- merit a brief mention. Price and return behavior of stocks around international listings is investigated in many studies. Howe and Kelm (1987), Lee (1991), Torabzadeh, Bertin and Zivney (1992), Varela and Lee (1993) and Lau, Diltz and Apilado (1994) examine the effects of listings on US stocks on foreign exchanges, while Alexander, Eun and Janakiramanan (1988), Foerster and Karolyi (1993), Jayaraman, Shastri and Tandon (1993), Miller (1999), Foerster and Karolyi (1999), Errunza and Miller (2000) and Bailey, Karolyi and Salva (2006) look at the effects of foreign stock listings in the US.[3] Studies on the listings of US stocks overseas find mixed evidence on the pre-listing and post-listing return effects. Studies on the effects of foreign listings on US exchanges, on the other hand, *generally* find statistically significant increases in pre-listing returns and significant decreases in the post-listing returns.

Liquidity effects of international listings are studied by Werner and Kleidon, (1996), Noronha, Sarin Saudagaran (1996), Foerster and Karolyi (1998) and Domowitz, Glen and Madhavan (1998)[4]. Bid-ask spreads are generally investigated as a measure of liquidity. While some of the studies find decreases in bid-ask spreads after international listings (e.g. Foerster and Karolyi, 1998; Domowitz, Glen and Madhavan, 1998) suggesting an increase in liquidity, some others find no significant change in the spreads (e.g. Noronha, Sarin Saudagaran, 1996).

There are also studies investigating the cost of capital and valuation effects of international listings (e.g., Sundarem and Logue, 1996; Errunza and Miller, 2000; Hail and Leuz, 2005; Sarkissian and Schill, 2009). A general finding is a reduction in the cost of capital and increase in value. For example, in a recent study, Sarkissian and Schill (2009) test whether there are any permanent valuation gains to overseas listings. They use a global sample of 1,676 listings from 1,130 firms in 25 countries and employ a wide event window of 120 months prior and after listing to detect any permanent valuation gains as a result of a decrease in the cost of equity capital. By controlling for the sequence chronology of foreign listings, they find strong evidence in favor of a transitory valuation effect during the five years following the listing, but they detect no significant cost of equity capital reduction five to ten years following the listing period, both relative to the equivalent pre-listing period.

Effects of international listings on stock risk are relatively less investigated. Among the most influential papers are Howe and Madura (1990), Torabzadeh, Bertin and Zivney (1992), Foerster and Karolyi (1993) and Jayaraman, Shastri and Tandon (1993).

Howe and Madura (1990) investigate the impacts of international listings on stock risk in the context of capital market integration. Using quarterly return data for a sample of 68 US firms, whose stocks are listed internationally (in Germany, France, Japan, Switzerland) they test whether there is any permanent shift in different risk measures after cross-listing. Their measures of risk include 5 elements: Domestic beta, which is the market risk with respect to US market portfolio on a single index model, domestic beta with respect to US market portfolio on a two-index model, "foreign beta" with respect to

[3] See Karolyi (2006) for a comprehensive survey on the effects of cross-listings.
[4] See Karolyi (2006).

the market portfolio of the country of listing, standard deviation of returns, R-square of the single-index and two-index models as a proxy for listing-as-integration-mechanism and residual variance of the two-index model as a proxy for changes in information asymmetry. They find slight decreases in beta values, standard deviation and residual variances and slight increases in R-square values, but all the changes are statistically insignificant. Thus, they conclude that markets are either already well integrated or international listing is not an effective way to reduce segmentation.

Torabzadeh, Bertin and Zivney (1992) test the hypothesis that international listing of a US stock will have an increasing effect on its price and a decreasing effect on its domestic market risk. Criticizing the work of Howe and Madura (1990) on the basis of lower statistical power because of using quarterly data, they use daily data to obtain statistically more powerful results. They use a regression model to test any shift in market-related risk measures for a 100-day pre and post-listing event window (from t=-160 to t=-61 and from t=+61 to t=+160) and find significant changes in market risk for only a few stocks, and reject the hypothesis that international listings of US stocks are associated with changes in their market risk behavior. They also find no significant shift in other risk measures, such as total risk and unsystematic risk.

Foerster and Karolyi (1993) examine, among other effects, the impact on stock risk of Canadian stock listings in the US exchanges. Specifically, they look at the impacts of interlisting on two risk measures, standard deviation of returns (total risk) and the covariance of returns with the market portfolio (market risk or *beta*). They use a 100-days event window before and after listings. Their results are consistent with those of Howe and Madura (1990) and Torabzadeh, Bertin and Zivney (1992). They find statistically insignificant downward shifts in both total risk and market risk.

Jayaraman, Shastri and Tandon (1993) investigate the effects of American Depository Receipt listings on the risk and return of the underlying stock. They use a 125-day pre-listing and post-listing period to compare volatilities before and after the listings. Their results show that there is a statistically significant positive relation between ADR listings and stock volatility. On the average, there is a 55.7% increase in stock volatility as a result of ADR listings.

3 Data and Methodology

A sample of 64 US firms, whose shares were cross listed on Xetra of Frankfurt Stock Exchange, Euronext Paris, SIX Swiss Stock Exchange and Tokyo Stock Exchange between 1985 and 2006 were used. The sample includes 5 US firms cross-listed on Xetra, 2 US firms on Euronext Paris, 22 US firms on SIX Swiss and 35 US firms on Tokyo Stock Exchange. First listing dates of stocks were obtained from the web sites of the exchanges. Dates obtained from the web sites were confirmed with e-mail contacts with the exchanges. Stock price and market index data were obtained from the Datastream. Country market indices (the US, Germany, France, Switzerland and Japan) are from the Morgan Stanley Capital International (MSCI). To estimate the risk measures, Howe and Madura (1990) use 4 years of quarterly data before and after the listing dates, however, we use 4 years of monthly data to increase the statistical power of the models. Since 4 years of data is required, listings after 2006 were excluded from the sample.

This paper focuses on the effects of international listings on stock risk and related measures, motivated by the idea that if capital markets are segmented, international listings should have significant effects on stock characteristics because of the theoretical expectation that cross-listings reduce segmentation. Stock risk is the covariance of returns with respect to the market portfolio (beta), which is calculated by regressing stock returns on the market portfolio returns. The methodology used is similar to an event study; however, since we look at the risk characteristics the "event window" covers a much longer time period. Four years of monthly data before and after the listings is used to calculate a number of risk measures and test whether there are any statistically significant changes before and after listings. All tests are based on a 5% significance level.

Domestic Beta

The first risk measure is the covariance of the total stock return with respect to domestic market portfolio, the US market portfolio. This measure represents the "domestic beta" of any particular stock. According to the theory discussed in Section-2, it is more probable that domestic beta should decrease as a result of international listing. Therefore, the null hypothesis is that pre- and post-domestic beta values are equal and the alternative hypothesis is one-sided:

H_0: $\beta_{d\text{-}pre} = \beta_{d\text{-}post}$
H_1: $\beta_{d\text{-}pre} > \beta_{d\text{-}post}$

The domestic beta values are estimated by two different models. The first is a single-index model, in which the market portfolio is the US market:

$$R_i = a_i + b_i R_{M,US} + \varepsilon_i \quad (1)$$

where, R_i is the total return of stock i, b_i is the "domestic beta" and $R_{M,US}$ is the total return on the US market portfolio.

The second model is a two-index model, which includes both the domestic market portfolio and the foreign market portfolio:

$$R_i = a'_i + c_i R_{M,US} + d_i R_{M,FOR} + \xi_i \quad (2)$$

where, R_i is the total return of stock i, c_i is the "domestic beta", d_i is the "foreign beta", $R_{M,US}$ is the total return on the US market portfolio and $R_{M,FOR}$ is the total return on the country of listing market portfolio.

Foreign Beta

The second risk measure is "foreign beta", d_i in Eq-2, which is the covariance of stock returns with respect to the market index return in the country of listing. If capital markets are segmented and international listings decrease segmentation, then foreign beta should increase, because it represents the exposure of a stock to the market in the country of listing. If capital markets are integrated, there should be no change in foreign beta after the listings. Therefore, the null hypothesis is that pre- and post-foreign beta values are equal and the alternative hypothesis is again one-sided:

H_0: $\beta_{f\text{-}pre} = \beta_{f\text{-}post}$
H_1: $\beta_{f\text{-}pre} < \beta_{f\text{-}post}$

Total Risk

The third risk measure investigated is total risk, the standard deviation of stock returns before and after the listings. According to Foerster and Karolyi (1993), if international capital markets are not perfectly correlated, total risk should decrease because of the diversification effect after international listings, as exposures to domestic market decrease and exposures to foreign markets increase as a result of cross-listings. The models of Kyle (1985) and Admati and Pfleifelder (1988), on the other hand, imply increased return variance, mainly as a result of increased information, trading volume, time and number of informed traders. Therefore, the null hypothesis is that pre- and post-standard deviations are equal and the alternative hypothesis in this case is two-sided:

H_0: $\beta_{f\text{-}pre} = \beta_{f\text{-}post}$
H_1: $\beta_{f\text{-}pre} \neq \beta_{f\text{-}post}$

Coefficient of Determination

The fourth measure is the coefficient of determination of the single-index and two-index models (R^2). The coefficient of determination is a measure of the percent of a stock's variance explained by the market. Therefore, if capital markets are segmented and international listings decrease segmentation, R^2 of the single-index model should decrease and R^2 of the two-index model should increase. The reason for expecting a decrease in R^2 of the single-index model is the reduced exposure to domestic market after the listing, which reduces the explanatory power of the model. In a similar vein, R^2 of the two-index model is expected to increase after the listing as the exposure to foreign market increases which increases the explanatory power of the two-index model. It follows then that, for the single-index model, the null hypothesis is no change in R^2 and alternative hypothesis is that R^2 decreases (one-sided). For the two-index model the null hypothesis is no change in R^2, the alternative hypothesis is an increase in R^2. Formally;

for the single-index model;

H_0: $R^2_{pre} = R^2_{post}$
H_1: $R^2_{pre} > R^2_{post}$

for the two-index model;

H_0: $R^2_{pre} = R^2_{post}$
H_1: $R^2_{pre} < R^2_{post}$

Residual Variance

The last measure of risk is the residual variance (non-systematic risk or firm-specific risk) of the single-index and two-index models. Howe and Madura (1990) use residual variance as a proxy for information asymmetry to test whether overseas listing decreases information asymmetry. The theoretical expectation is that information asymmetry should

decrease after international listings as firms become subject to additional and different sets of disclosure requirements and standards. Additionally, listing overseas is expected to decrease the cost of information for the investors about the firm in the foreign country of listing. Therefore, the null hypothesis is no change in residual variance and the alternative hypothesis is a decrease in residual variance:

H_0: $RV_{pre} = RV_{post}$
H_1: $RV_{pre} > RV_{post}$

4 Results

Domestic Beta

Test results for domestic beta from both single-index (b_i) and two-index (c_i) models are shown in Table-1 and Table-2, respectively. The Table includes the overall sample as well as four sub-samples.

Using the single-index model, the results in Table-1 show that there is a slight increase in average beta (from 0.65 to 0.67) for the overall sample, but it is statistically insignificant (t=-0.46). For the Xetra sub-sample, there is a statistically insignificant decrease (t=0.51) in average beta (from 0.63 to 0.57). There is again an increase for the Euronext Paris sub-sample but it is again statistically insignificant. However, there is significant decline in average beta values for the SIX Swiss sub-sample, from 0.77 to 0.59 with a t-statistic of 2.8. The statistically insignificant increase for the overall sample seems to be dominated by the Tokyo SE sub-sample, in which there is an increase from 0.55 to 0.70 in average beta (t=-2.59).

Using the two-index model, the results in Table-2 show that there is a decrease in the average beta values (from 0.67 to 0.57), but it is again statistically insignificant (t=1.34). There is statistically insignificant decrease for the Zetra and Euronext Paris, but there is significant decline in average beta values for the SIX Swiss, from 0.79 to 0.49 with a t-statistic of 3.79. For the Tokyo SE there is again a statistically insignificant increase in average beta, from 0.58 to 0.69 with a t-statistic of -1.79.

For both single-index and two-index models, an interesting result is obtained for the Tokyo SE sub-sample, in which there is an increase in domestic beta. However, since the previously defined hypothesis was one-way on the positive side, the increase is statistically insignificant.

Table 1: Pre- and Post-Listing Domestic Beta (b_i)-(Single-Index Model, $R_i = a_i + b_i R_{M,US} + \varepsilon_i$)

Sample	Sample Size	Average Pre-Listing Beta (b_i)	Average Post-Listing Beta (b_i)	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	0.65	0.67	-0.46	1.67
Xetra-Frankfurt SE	5	0.63	0.57	0.51	2.13
Euronext Paris SE	2	1.05	1.43	-0.19	6.31
SIX Swiss SE	22	0.77	0.59	2.80	1.72
Tokyo SE	35	0.55	0.70	-2.59	1.69

Table 2: Pre- and Post-Listing Domestic Beta (c_i)-(Two-Index Model, $R_i=a'_i + c_iR_{M,US} + d_iR_{M,FOR} + \xi_i$)

Sample	Sample Size	Average Pre-Listing Beta (c_i)	Average Post-Listing Beta (c_i)	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	0.67	0.57	1.34	1.67
Xetra-Frankfurt SE	5	0.72	0.51	1.54	2.13
Euronext Paris SE	2	0.94	-0.63	0.67	6.31
SIX Swiss SE	22	0.79	0.49	3.79	1.72
Tokyo SE	35	0.58	0.69	-1.79	1.69

Foreign Beta

Test results for foreign beta from the two-index (d_i) model are shown in Table-3. The results show a significant increase in foreign beta for the overall sample, which is consistent with the previously defined hypothesis that if capital markets are segmented, then foreign beta should increase after cross-listings. SIX Swiss and Tokyo SE sub-samples also show significant increases in foreign beta values. Increases for Xetra and Paris sub-samples are insignificant, but considering their relatively small sample size, it can be inferred that there is also a significant increase in foreign beta values for the sub-samples.

Table 3: Pre- and Post-Listing Foreign Beta (d_i)-(Two-Index Model, $R_i=a'_i + c_iR_{M,US} + d_iR_{M,FOR} + \xi_i$)

Sample	Sample Size	Average Pre-Listing Beta (d_i)	Average Post-Listing Beta (d_i)	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	-0.058	0.146	-3.19	1.67
Xetra-Frankfurt SE	5	-0.138	0.068	-1.44	2.13
Euronext Paris SE	2	0.163	2.549	-2.02	6.31
SIX Swiss SE	22	-0.037	0.184	-3.45	1.72
Tokyo SE	35	-0,073	-0.005	-2.22	1.69

Total Risk

Test results for total risk measure (standard deviation of stock returns) are shown in Table-4. For the overall sample and Xetra and SIX Swiss sub-samples, the results suggest a significant increase in total risk, which is consistent with the models of Kyle (1985) and Admati and Pfleifelder (1988), who anticipate an increase in total risk, mainly as a result of increased information, trading volume, time and number of informed traders. For the Euronext Paris and Tokyo sub-samples, there are again increases in total risk, but these changes are statistically insignificant.

Table 4: Pre- and Post-Listing Total Risk-(Standard Deviation of Stock Returns)

Sample	Sample Size	Average Pre-Listing Total Risk	Average Post-Listing Total Risk	T-statistic for Difference in Means	T-critical (two-tail)
Overall Sample	64	0.080	0.096	-3.49	2.00
Xetra-Frankfurt SE	5	0.065	0.095	-7.65	2.78
Euronext Paris SE	2	0.206	0.348	-1.32	12.71
SIX Swiss SE	22	0.071	0.089	-3.36	2.08
Tokyo SE	35	0.080	0.087	-1.63	2.03

Coefficient of Determination (R^2)

Results for the R^2 tests are shown in Table-5 for the single-index model and in Table-6 for the two-index model. For the single-index model, there is a slight increase in average R^2 values for the overall sample, as opposed to the previously defined hypothesis, but the increase is statistically insignificant. T-statistics for the sub-samples as well indicate statistically insignificant changes.

Table 5: Pre- and Post-Listing R^2-(Single-Index Model, $R_i=a_i + b_iR_{M,US} + \varepsilon_i$)

Sample	Sample Size	Average Pre-Listing R^2	Average Post-Listing R^2	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	0.14	0.16	-0.75	1.67
Xetra-Frankfurt SE	5	0.15	0.15	0.0	2.13
Euronext Paris SE	2	0.04	0.18	-0.63	6.31
SIX Swiss SE	22	0.12	0.10	1.45	1.72
Tokyo SE	35	0.16	0.19	-1.19	1.69

There is a slight increase after the listings in the R^2 of the two-index model for the overall sample, consistent with the defined hypothesis. However, the change is again statistically insignificant both for the overall sample and sub-samples.

Table 6: Pre- and Post-Listing R^2 - (Two-Index Model, $R_i=a'_i + c_iR_{M,US} + d_iR_{M,FOR} + \xi_i$)

Sample	Sample Size	Average Pre-Listing R^2	Average Post-Listing R^2	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	0.17	0.18	-0.58	1.67
Xetra-Frankfurt SE	5	0.17	0.15	0.39	2.13
Euronext Paris SE	2	0.07	0.27	-0.93	6.31
SIX Swiss SE	22	0.14	0.12	0.99	1.72
Tokyo SE	35	0.19	0.21	-0.80	1.69

Residual Variance

Table-7 and Table-8 show the results for the residual variance tests, under the single-index and two-index models, respectively. For the single-index model, there is an increase in the post-residual variance for the overall sample, but the change is statistically insignificant. Similar results are obtained for the sub-samples, there is an increase in the residual variance values for all of the 4 four sub-samples. But the changes are again statistically insignificant[5].

Table 7: Pre- and Post-Listing Residual Variance (RV)-(Single-Index Model, $R_i=a_i + b_iR_{M,US} + \varepsilon_i$)

Sample	Sample Size	Average Pre-Listing RV	Average Post-Listing RV	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	0.074	0.088	-2.98	1.67
Xetra-Frankfurt SE	5	0.061	0.087	-6.45	2.13
Euronext Paris SE	2	0.202	0.323	-0.90	6.31
SIX Swiss SE	22	0.067	0.085	-3.46	1.72
Tokyo SE	35	0.073	0.077	-1.08	1.69

Results are similar for the two-index model. Overall, there is an increase in the residual variance after the listings. Except for the Euronext Paris sub-sample, all sub-samples experience an increase in the residual variance after the listings. Bu again, results are statistically insignificant[6].

Table 8: Pre- and Post-Listing Residual Variance (RV)-(Two-Index Model, $R_i=a'_i + c_iR_{M,US} + d_iR_{M,FOR} + \xi_i$)

Sample	Sample Size	Average Pre-Listing RV	Average Post-Listing RV	T-statistic for Difference in Means	T-critical (one-tail)
Overall Sample	64	0.006	0.008	-3.1	1.67
Xetra-Frankfurt SE	5	0.004	0.008	-7.08	2.13
Euronext Paris SE	2	0.040	0.033	1.72	6.31
SIX Swiss SE	22	0.005	0.007	-2.99	1.72
Tokyo SE	35	0.006	0.007	-1.51	1.69

5 Conclusion

In the context of capital market integration, a sample of US firms whose shares were cross-listed internationally is examined for any evidence of changes in stock risk as a

[5] Although the absolute values of t-statistics are greater than t-critical values, the results are insignificant becasue the alternative hypothesis is one-tailed on the positive side, namely a decrease in the residual variance.

[6] See footnote 5.

result of international listings. If markets are segmented and cross-listing decrease segmentation there should be significant changes in stock risk after cross-listing. Several risk measures are tested for any significant change. Although we are not able to reject the hypothesis that domestic market betas do not change as a result of international listings (consistent with the results of Howe and Madura, 1990; Torabzadeh, Bertin and Zivney 1992; and Foerster and Karolyi, 1993), we find statistically significant evidence that cross-listings are associated with increases in foreign beta values. This means that sensitivity of stock returns to the common factors of the cross-listed countries increases, suggesting a decreasing effect of international listings on segmentation. Total risk of stocks are found to increase after cross-listings, consistent with the models of Kyle (1985) and Admati and Pfleifelder (1988), who anticipate an increase in total risk, mainly as a result of increased information, trading volume, time and number of informed traders. The increase in total risk is also consistent with the empirical findings of Jayaraman, Shastri and Tandon (1993). Overall, these results suggest evidence of capital market segmentation, rather than integration.

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