The Dual Listing of Austrian Companies in Vienna and Frankfurt: Dependence Analysis

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International capital flows can be hampered by a variety of barriers such as transaction costs, information costs, and legal restrictions. The solution in this situation can be dual listing. The framework of the research presented here assumes that domestic securities are dually listed on a foreign capital market, while none of the foreign securities is dually listed on the domestic capital market. This paper is concerned with a dependence analysis of the log-levels and returns of Austrian stocks listed in Frankfurt and Vienna. The important issue is dynamic linear and non-linear causality between log-levels (returns) of prices and the indices ATX and DAX. In this context the important directions of causality are found along with the level of relations of the selected types of causality.

Key words: dual listing, linear and non-linear causality, cointegration

Introduction

Nowadays, economists observe the internationalization of the world's financial markets. This problem has received much attention in both practice and research. One aspect of this kind of globalization is the listing of firms' equity securities on foreign stock exchanges.

Usually the contributors of papers try to provide some insights into the following questions:

- What are the major costs and benefits of foreign listing?
- What are the key determinants of the perceived net benefits of foreign listing?

However, we are not concerned in this contribution with these questions. Our main goal is to identify dependencies between domestic and foreign price listings.

The expected advantages of foreign listings are in liquidity, and the visibility and prestige of the company. A very important goal is to access foreign sources of capital, and to reduce political risk in the foreign country in which the stocks are being listed. Possible disadvantages include additional costs in maintaining listing status, and regulatory uncertainty about the foreign stock exchange.

Up to now the properties of dual listings on US domestic stock exchanges are relatively well-recognized. The issue has received much attention in the research. However, the number of studies on dual listings is limited. In addition, the reported results are not always compatible. In one of the earliest studies, which was conducted by Howe and Kelm (1987) the impact of listings by US firms on the Basel, Frankfurt, and Paris stock exchanges was investigated. The results presented by the contributors reflect essential drop in the prices of the listed stocks around the listing period. However, a following contribution by Lee (1991) suggests no significant price effects for US firms resulting from dual-listing on either the London or Toronto Stock Exchange.

The main goal of this paper is to provide empirical evidence on the price effects of dual listings on the Frankfurt (FSE) and the Vienna Stock Exchange (VSE) by Austrian firms.

The paper is scheduled as follows: the next section contains a literature review. The third section presents data from the Frankfurt and Vienna Stock Exchanges and methodology. The fourth section outlines and discusses the empirical tests. The final section contains a summary and conclusions.

Literature overview

Under globalization, dual listings are widely observed. However the advantages and disadvantages of dual listing are discussed only in a few studies. The authors tried to examine the valuation impact of such listings. In the above mentioned contribution by Howe and Kelm (1987) the authors tested the effects of listings on the Basel, Frankfurt and Paris stock exchanges for 165 US firms over the period 1962–1985. The contributors found that dual listings cause a significant stock price decline for the US companies' shareholders. The recommendations were that US corporate managers should not start foreign listings, because the advantages of such listings are outweighed by the costs.

Alexander, Eun, and Janakiramanan (1988) checked the price effects of 34 non-US firms that were listed to either the US stock exchange or the NASDAQ system. They show that shareholders of foreign firms benefit from such listings. This was confirmed by positive cumulative average residuals over the prelisting period. The contributors in summary stated that the results supported their hypothesis that global capital markets were completely or at least to some extent segmented. Lee (1991) tested the effects of foreign listings for 141 US companies that dual-listed on the London or Toronto Stock Exchange over the period 1962–1986. Lee did not detect any significant, long-term changes in stock prices. This clearly contradicts Howe and Kelm (1987) and Alexander, Eun, and Janakiramanan (1988).

Biddle and Saudagaran (1989) checked the links between financial disclosure levels and choices among alternative foreign stock exchange listings. By means of cross-sectional univariate and multivariate analysis for 207 internationally-traded firms, they found that firms are less likely to list their stocks on overseas exchanges with higher disclosure levels than those of their home stock exchanges. The authors established that both the direct and indirect financial disclosure costs accompanying foreign listing are an important factor in a company's listing decision.

Saudagaran (1988) is concerned with the reasons for foreign stock listing abroad. On the basis of a sample which consisted of 481 multinational firms with foreign listings as of December 1981, the author detected a significant relationship between foreign listings and two factors: the relative size of a firm in its domestic stock market and the ratio of foreign to total sales.

Fry, Lee, and Choi (1994) tested the valuation effects of dual listings on the Tokyo Stock Exchange (TSE) for US companies. The contributors found a significant rise in prices for the shareholders of US firms that list stocks on the TSE through 1988. The authors proven that large benefits can be enjoyed by those firms that do not have a business presence in Japan at the time of listing and for which the Tokyo listing is its first. Their results support the hypothesis that there are systematic benefits inherent in a multinational business network and diminishing marginal returns to foreign listings.

As we see these findings are in sharp contrast with losses previously reported by Howe and Kelm and Lee's finding of no significance. The empirical results are consistent with those of Alexander, Eun, and Janakiramanan (1988).

Radebaugh, Gerbhardt, and Gray (1995) stress that Daimler-Benz's decision to list in the USA was part of its globalization strategy to re-

duce the discrepancy between its international operating activities and the structure of its shareholders. It had 40% of its sales revenues from overseas but only 7.2% of its shares trading outside of Germany. Most of the firms in samples in different contributions e. g. Bancel and Mittoo (2002) reflect a similar situation. These companies have business operations in many parts of the world but their stock is traded primarily on the home exchanges.

In a study by Pagano, Roell, and Zechner (1999) the authors documented that cross-listings of European companies appear to have sharply different motivations and consequences depending on whether they cross-list in the USA or within Europe. Cross-listing in the USA appears to be driven by the need to raise equity to fund growth and foreign sales expansion, generally in high-tech sectors while cross-listing in Europe is less motivated by these factors. Karolyi (1998) reported that firms based in most geographical regions including Canada experience a decline in the estimated cost of capital after listing in the USA but that the opposite is true for the European (non-UK) firms.

Using event study methodology, Miller (1999) and Foerster and Karolyi (1999) detected abnormal returns in the underlying domestic stocks surrounding the international listing date. The foregoing empirical evidence is indicative of the impact of international listing on the stock in the domestic market.

Bancel and Mittoo (2002) survey European managers on the costs, benefits, and net benefits of foreign listing. An increase in prestige and visibility, and growth in shareholders are perceived as the major benefits, and the costs of public relations and legal fees are cited as the major costs by the managers. While a majority of managers (60%) perceive that the benefits outweigh the costs of foreign listing, about 30% view the net benefits to be negative. Perceived net benefits are positively related to an increase in total trading volume after foreign listing, the financial disclosure levels of the firm, and dual listing on both the US and European foreign exchanges. Without the influence of these factors, the perceived net benefits are negative. Many managers from the sample in the project by Bancel and Mittoo (2002) stress that the implementation of globalization strategy is a major benefit and consequence of foreign listing. Their results are in line with the survey of non-US firms by Fanto and Karmel (1997). In this study most firms reported US business-related reasons as the main reason for listing in the USA.

Baker, Nofsinger, and Weaver (2002) documented that the international listing of a stock incluces greater attention among the in-

TABLE 1 Financial Times Series

Company	Symbols	Company	Symbols
Erste Group Bank	D.EBO	Telekom Austria	D.TA1
	O.ERS		O.TKA
Raiffeisen Bank International	D.RAW	Verbund	D.OEWA
	O.RAI		O.VERB
OMV	D.OMV	CA Immobilien Anlagen	D.BZY
	O.OMV		O.CAIM
Voestalpine	D.VAS	Vienna Insurance Group A	D.WSV2
	O.VAS		O.WNST
Andritz	D.AZ2	Uniqa Insu Gross AG	D.UN9
	O.AND		O.UNIQ
Immofinanz	D.IMO	Oesterreichische Post	D.O3P
	O.IMMO		O.OES

NOTES Based on data from Thompson Reuters Datastream; the extracted time series refer to the trading period from 1 January 2010 to 15 October 2014.

vestment community as measured by the number of analysts following it and the media coverage. They also showed that the systematic risk as measured by beta goes down and hence the capital costs of the firm tend to decline following the listing of non-US stocks on the New York Stock Exchange (NYSE).

Reese and Weisbach (2002) claimed that non-US firms that list their stocks on the NYSE or NASDAQ increase the expected cost to managers of extracting private benefits due to a number of provisions in US securities law. As a result such firms will be able to access capital from the US market at a lower cost.

Data and Methodology

DESCRIPTIVE STATISTICS

We consider the daily prices of dual listed stocks on the Vienna and Frankfurt Stock Exchange (11 pairs, see table 1) along with main indices DAX30 (DAX) and ATX20 (ATX). The dataset covers the period from 1 January 2010 to 15 October 2014 and was extracted from Thomson Reuters Datastream. The prices of dual listed stocks are very close. Regarding all pairs, maximal price differences (in absolute value) do not exceed 2.3 (2.8 on 30 October 2009 Vienna Insurance Group). Instead of using series of prices we use natural logarithms of all prices to diminish and stabilize variances (from now on we refer to them as log-levels of prices). In addition, differencing log-levels leads to continuous returns. Tables 2 and 3 present main descriptive statistics.

TABLE 2 Descriptive Statistics of Stock Indices

Index	Mean	Standard dev.	Skewness	Kurtosis
DAX	8.90	0.17	0.23	1.97
ATX	7.78	0.12	−0.47	2.60

TABLE 3 Descriptive Statistics of Individual Stocks

Quartiles	Mean	Standard dev.	Skewness	Kurtosis
Minimum	0.83	0.11	−0.94	1.53
1st quartile	2.39	0.13	−0.44	1.76
median	3.28	0.22	−0.09	2.13
3rd quartile	3.37	0.25	0.07	2.41
Maximum	3.59	0.28	0.40	3.31

TABLE 4 Results of Unit Root Test

Item	DF-GLS		KPSS	
	Min	Max	Min	Max
Log-levels	−3.29	−1.38	0.82	2.44
First difference of log-levels	−29.15	0.02	0.11	0.32

For all series under consideration the values of skewness and kurtosis indicate departure from normality. The null hypothesis in the Jarque-Bera test is rejected in all cases. Additionally, the Ljung-Box test indicates the presence of autocorrelation in time series.[1]

STATIONARITY OF THE DATA

In the next step we apply tests for stationarity (including DF-GLS and KPSS tests) either for log-levels or for their first differences. The DF-GLS test critical values are −3.43, −2.86 and −2.57 (for 1, 5 and 10% significance level respectively), whereas the KPSS test critical values are 0.119, 0.146 and 0.216 (for 10, 5 and 1% respectively). The test statistics of the DF-GLS for DAX and ATX for log-levels are −2.69 and −2.25, respectively. When using the KPSS test we obtain values 1.79 and 1.74 respectively. Applying tests for differenced series we obtain −25.06 and −24.31 (in the DF-GLS test) and 0.05 and 0.07 (in the KPSS test). Table 4 summarizes the results of unit root testing for all stocks.

We find that none of the series are trend stationary, so we may conclude that all log-level series are nonstationary (integrated of order 1) and thereby the logarithmic returns are stationary.

COINTEGRATION

The same order of integration and similarity patterns of dual listed stocks (in levels) can lead to conclusion of cointegration, and this

can be formally tested. We apply the Johansen procedure based on either trace or maximum eigenvalue test statistics with and without intercept in cointegrating relations. In all cases there is no reason to reject the hypothesis that the cointegration rank is equal to one. It is well known that the Johansen procedure is sensitive to lag selection. To check the robustness of our findings we apply the procedure of Phillips and Ouliaris (1990). Computed test statistics based on the Johansen procedure confirm the presence of cointegration. In all cases of dual listed stocks there exists a long run relationship.

Methodology-Causality Testing

To analyze causality patterns we apply linear and non-linear tests. Although all series are integrated of order one we do not difference them when testing linear causality. Instead, we follow the procedure of Toda and Yamamoto (1995) which can by applied for possibly non-stationary and cointegrated series. We consider the bivariate VAR(k) model:

$$y_t = \Phi_0 + \sum_{i=1}^{k} \Phi_i y_{t-i} + \varepsilon_t, \tag{1}$$

where Φ_0 is the vector of intercept parameters, $\Phi_i = \begin{pmatrix} \Phi_{11,i} & \Phi_{12,i} \\ \Phi_{21,i} & \Phi_{22,i} \end{pmatrix}$ are the matrices of parameters and the ε_t vector stands for white noise process. Appropriate lags are chosen by the BIC information criterion and tests of autocorrelation. We choose lowest lag which ensuses the lack of autocorrelation of residuals. In all cases VAR models with at most four lags fit the best. Then we reestimate VAR models for $k+1$ lags (the additional lag comes from the degree of integration of series) and use the Wald test (Toda and Yamamoto 1995), applied only to first k lags. Under the null hypothesis of the Granger non-causality the test statistic is asymptotically χ^2_k distributed.

To complement the causality analysis we performed a Diks and Panchenko (2006) nonparametric causality test. As with the linear causality setting we test null hypothesis of Granger non-causality. Given two stationary series X_t, Y_t, the null hypothesis is equivalent to testing for conditional independence of Y_t:

$$H_0: \quad Y_t | (X_{t-1}^{l_x}; Y_{t-1}^{l_x}) \sim Y_t | Y_{t-1}^{l_y}$$

where $Y_{t-1}^{l_y} = (Y_{t-l_y}, \ldots, Y_{t-1})$ and $X_{t-1}^{l_x} = (X_{t-l_x}, \ldots, X_{t-1})$. The null hypothesis states the invariance distribution of $(l_x + l_y - 1)$ dimensional vector $W_t = (X_{t-1}^{l_x}, Y_{t-1}^{l_y}, Z_t)$ with $Z_t = Y_t$. Assume that $l_x = l_y = 1$. If we ignore the time index then the null hypothesis implies:

TABLE 5 Results of Linear Causality Testing

Null hypothesis	Number of rejections of null	Number of bidirectional cases
O does not Granger cause D	11	4
D does not Granger cause O	4	
ATX does not Granger cause O	7	0
O does not Granger cause ATX	1	
ATX does not Granger cause D	11	1
D does not Granger cause ATX	1	
DAX does not Granger cause O	6	0
O does not Granger cause DAX	0	
DAX does not Granger cause D	11	2
D does not Granger cause DAX	2	

$$q \equiv E(f_{X,Y,Z}(X,Y,Z) - f_{X,Y}(X,Y) f_{Y,Z}(Y,Z)) = 0,$$

where $f.$ are probability density functions. Let

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} \sum_i \left(\widehat{f}_{X,Y,Z}(X_i,Y_i,Z_i) - \widehat{f}_{X,Y}(X_i,Y_i) \widehat{f}_{Y,Z}(Y_i,Z_i) \right),$$

where $\widehat{f}.$ are the local density estimates and $\varepsilon_n = Cn^{-\beta}$ is the bandwidth with $C > 0$ and $\beta \equiv (\frac{1}{4}, \frac{1}{3})$ with sample size n. Under the null hypothesis the test statistic has an asymptotically standard normal distribution

$$\sqrt{n} \frac{T_n(\varepsilon_n) - q}{S_n} \xrightarrow{D} N(0,1).$$

where S_n is the asymptotic variance of $T_n(\varepsilon_n)$.

Empirical Results

The procedures described above are applied to different pairs of series along with indices. Table 5 presents the number of rejections of the null hypothesis of non-causality at a 0.05 significance level. For simplicity we apply the notation: O is a stock quoted on the Vienna Stock Exchange, D is a stock quoted on the Frankfurt Stock Exchange. Table 5 contains the results of causality testing.

There are few causal dependence patterns from these linear tests. In all pairs, stocks quoted on the Vienna Stock Exchange Granger cause stock prices from Frankfurt (in four cases feedback effect is observed). The main Austrian and German indices Granger cause stock prices listed on these markets. In addition, the DAX index causes stock prices quoted on the Vienna Stock Exchange. More-

over, we can observe causality running from the ATX to stock prices quoted on the Frankfurt Stock Exchange. In most cases we observe causality running from the DAX index to stock prices quoted on the Vienna Stock Exchange.

When testing for non-linear causality we follow the Dicks and Panchenko procedure (2006); while testing for nonlinear causality between O and D types of stocks, we take into account the results of cointegration analysis. First we estimate VECM models for dual listed stocks with different specifications of deterministic terms. The general form of VECM models is as follows:

$$\Delta y_t = \Pi_0 + \Pi y_{t-1} + \sum_{i=1}^{k} \Pi_i \Delta y_{t-i} + \varepsilon_t, \tag{2}$$

where Π_0 is the deterministic trend in levels and $\Pi_i \Delta y_{t-i}$ captures the short-run dynamics around a common stochastic trend. Component Πy_{t-1} captures the cointegration relationship with $\Pi = \alpha\beta'$. Vector α stands for the speed of adjustment parameters and β is the cointegrating vector. The selection of best fitted models is based on the BIC information criterion and significance tests of parameters. In table 6 we present estimated values of error correction terms for all pairs under consideration.

We observe that in all cases error correction terms (ECT) are negative for companies quoted on the Vienna Stock Exchange, and positive for companies listed in Frankfurt. In four cases the parameter of the error correction term from the first equation of (2) is not significant at a 10% level. We can conclude that if the error correction term $y_{1t-1} - \beta y_{2t-1}$ is positive, the price level of a stock of type O falls, and the price level of a stock of type D increases. It is worth mentioning that all ECT parameters are lower (in absolute value) for a stock of type O, so that adjustment to a long-run path is faster for stocks from the Frankfurt Stock Exchange. We tried to incorporate asymmetries into ECT as proposed by Granger and Lee (1989), but according to the BIC criterion we did not achieve a significant improvement.

The residuals from VECM models are used in nonlinear causality tests. In all remaining case pairs (non cointegrated series) we simply difference the series. In such a way we obtain log-returns. In the next step VAR modelsare estimated. Filtered series (from linear structure) are used to discover non-linear causality patterns.

We set $l_x = l_y = 1$ and a bandwidth parameter equal to 1, which is close to $C^* n^{-\frac{2}{7}}$, where $C^* \approx 8$, $\beta = -\frac{2}{7}$ (Diks and Panchenko 2006) and n is our sample size. Selecting a longer bandwidth results in smaller p-values and vice versa.

TABLE 6 Parameter Estimates of Error Correction Terms of VECM Model

Pair no.	Dual listed stocks	Error correction terms parameters
1	O.OMV	−0.419***
	D.OMV	0.518***
2	O.ERS	−0.217*
	D.EBO	0.807***
3	O.VAS	−0.211*
	D.VAS	0.432***
4	O.RAI	−0.132
	D.RAW	0.894***
5	O.WNST	−0.090
	D.WSV2	0.842***
6	O.AND	−0.164*
	D.AZ2	0.480***
7	O.TKA	−0.080
	D.TA1	0.710***
8	O.UNIQ	−0.073
	D.UN9	0.380***
9	O.OES	−0.134*
	D.O3P	0.805***
10	O.VERB	−0.224*
	D.OEWA	0.596***
11	O.IMMO	−0.224**
	D.IMO	0.644***

NOTES *** Significance at 1% level, ** Significance at 5% level, * significance at 10% level.

Additionally, to investigate volatility transmission, all series are filtered from conditional heteroscedasticity. For this purpose we apply the bivariate GARCH-BEKK(1,1) (Engle and Kroner 1995) model for heteroscedasticity filtering:

$$\sum_t = CC' + A\varepsilon_{t-1}\varepsilon'_{t-1}A' + B\sum_t B',$$

$$\varepsilon_t = \sum_t^{\frac{1}{2}} z_t,$$

where C,A and B are matrices of parameters (C is lower triangular), $\sum_t$ is the conditional covariance matrix of ε_t and z_t is an i.i.d. innovation vector with zero mean and an identity covariance matrix.

Standardized residuals from VAR/VECM are used in nonlinear causality testing. Table 7 presents the number of rejections of the null hypothesis of non-causality at a 0.05 significance level.

TABLE 7 Results of Nonlinear Causality Testing

Null hypothesis	(1)	(2)	(3)	(4)
O does not Granger cause D	6	5	5	1
D does not Granger cause O	7		2	
ATX does not Granger cause O	4	2	0	0
O does not Granger cause ATX	4		1	
ATX does not Granger cause D	10	4	2	0
D does not Granger cause ATX	5		1	
DAX does not Granger cause O	6	0	0	0
O does not Granger cause DAX	0		0	
DAX does not Granger cause D	10	2	4	0
D does not Granger cause DAX	3		1	

NOTES Column headings are as follows: (1) VECM/VAR filtered residuals, (2) number of bidirectional cases, (3) VECM/VAR-BEKK filtered residuals, (4) number of bidirectional cases.

When using residuals from VAR/VECM models, the causality patterns are in most cases in line with the linear causality tests. There are a few cases where the number of nonlinear dependencies is larger than linear (D does not Granger cause O, O does not Granger cause ATX, D does not Granger cause ATX and D does not Granger cause DAX).

When using standardized residuals of series, we observe that causal relationships disappear in most cases. If this is the case, we conclude that nonlinear causality is due to volatility effects. If we do not reject the null, we deduce that observed nonlinear relationships are due to asymmetries in conditional volatility or are caused by higher moments. Introducing an asymmetry component to GARCH-BEKK model gives an answer to the first supposition. There are cases when DAX does not Granger cause D (3 cases) and O does not Granger cause D (1 case) where rejection is caused by the asymmetric impact of an unconditional shock on conditional variances. Otherwise nonlinear causality can be observed in higher conditional moments.

Conclusions

Recent developments in the international capital markets have caused a lively debate about the value and reasonability of foreign listing for World and particularly European firms. The opponents of dual listing argue that with the introduction of a single currency in Europe, dual listings on the European stock exchanges are not necessary. In addition, with the increasing globalization of capital markets

and the international approach of most fund managers, many argue that dual listing may also not serve a useful purpose for most firms especially those acting within Europe.

In our contribution we provide evidence on some patterns of dual listings. This study provides empirical evidence regarding the effects of dual listings for Austrian firms. Using a sample of 11 Austrian firms that list also on the Frankfurt Stock Exchange our study reports that foreign listings do not cause any significant and permanent changes in domestic stock prices. The stock prices of Austrian companies listed in Frankfurt and Vienna are quite similar. The results about linear causality suggest that prices in Frankfurt of Austrian stocks are caused by prices of these stocks in Vienna. In general no reciprocal relationship exists. In more than 50% of cases is there is feedback.

The prices of dual listed stocks depend causally on the level of the DAX and ATX. Nonlinear causality tests indicate that the levels of the DAX or ATX determine the log-levels of dual listed Austrian stocks. Other non-linear causalities are not so strongly pronounced. The analysis of cointegration indicates that companies from Frankfurt adjust to an equilibrium path faster than domestic companies.

Notes

1. All details of results are available from the authors upon request.

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