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CONTENTS

DYNAMIC RELATIONSHIPS BETWEEN ISHARES AND COUNTRY FUNDS: THE CASE OF EUROPE AND ASIA

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ABSTRACT

This study investigates whether country effects or regional effects are prominent in iShares and country funds that trade in the US. iShares and country funds from three European and three Asian countries are investigated for possible long run and short-run relationships among iShares and country funds of each country and among regional iShares and among regional country funds. Johansen's methodology is used to investigate long-run relationships, while vector autoregression is used to detect short-term effects. It is found that for both regions, iShares and country funds are related to their country counterparts but not to their regional counterparts in the short run. The reverse is true in the long run, with relationships among regional counterparts but not among country counterparts. These findings support the hypothesis that country effects are prominent in the short-run and regional effects take over in the long run.

INTRODUCTION

Diversification in international markets can be achieved by investing in various assets such as foreign stocks, mutual funds, iShares, etc. However, relationships among these assets could lead to a reduction in diversification gains. Hence, a comparison of regional or country relationships would provide immense benefit to an investor seeking diversification. An asset may show relationships with other assets of the same country or with assets of other countries in the same region. This paper hypothesizes that in the short-run, international assets may show relationships with assets of their own country, but in the long run, they are related with the regional assets. Such effects may be due to the dominance of country-related factors in the short run. However, such factors may not have any regional implications. On the other hand, in the long run, investors tend to invest on a regional basis and hence, there may be a dominance of regional factors.

To investigate this hypothesis, this paper utilizes iShares and country funds of six countries representing two regions: Asia and Europe. Only iShares and country funds have been used because they both represent a diversified portfolio in a single country. International stocks may experience an effect from company-specific (events) effects in addition to country and regional effects. This is not within the scope of this paper. iShares, which track the Morgan Stanley Capital Index (MSCI) of a specific country, comprise all the stocks included within that index. As such, they represent a passive investment in a particular country. Due to their passive nature, they have low fees. iShares can also be bought and sold at any time during a trading day for a commission. There are no early redemption fees or penalties. Closed-end country funds invest in a small sample of stocks in a specific country. Country funds are actively managed investments in a country and, hence, have higher fees than iShares. There are early redemption penalties for country funds. Regardless of their differences, they both represent a diversified portfolio that is affected by country and regional factors.

Studies in the past have investigated relationships among regional assets. For example, Dunis and Shannon (2005) investigate the diversification potential offered by the Southeast and Central Asian markets and find increased relationships with the Japanese market, but not with the US or UK markets. However, most of these relationships have been among indices representing the countries of these regions. Thus, these studies have not been able to utilize investible assets such as iShares and country funds. Studies that have investigated iShares and country funds and the effects of a country or region on them have looked at them separately, not in unison. A few studies have looked at the relationship between iShares and country funds of a specific country, but have not extended their study to include regional factors. The contribution of this paper arises from the fact that it provides investors an indication of the factors that may affect assets of a country. It compares country effects with regional effects. It also provides investors guidance regarding diversification gains or the lack thereof, depending on their investment time window.

Investigation of three countries each in Europe and Asia show that in the short-run for all the countries (except Singapore) there is a relationship among a country's iShare and its country fund. However, few relationships are found among regional iShares and among regional country funds. Long-run relationships show a different picture in that iShares and country funds separately are more often related to their regional counterparts than to their country counterparts. The following section reviews the literature on this topic. It is followed by the data and methodology used in this paper. Next, a discussion of results is presented and then the paper concludes with some insights.

LITERATURE REVIEW

Investors are well served by investing and thus diversifying in international markets. Dunis and Shannon (2005) show that a portfolio consisting of emerging stocks outperformed one consisting of only US stocks. A major impediment in diversification gains would be relationships or effects among various assets included in a portfolio. Such relationships might arise in international assets for, but not limited to, two reasons: their relationship to the economic factors affecting the countries that they represent and/or their relationships to the regional countries.

Studies in the past such as Pennathur, Delcoure and Anderson (2002) and Patro (2001) have investigated the effect on iShares and country funds from their countries. While Khorana and Nelling (1998) test and compare how accurately the iShares and CECFs track the index of the countries they represent. On the other hand, Pennathur, Delcoure and Anderson (2002) investigate the relationship that iShares and country funds have with both their respective home countries and the U.S., the market in which they trade. They show that, while country funds follow the U.S. market, iShares show more exposure to home country returns. Both these studies investigate the effects of country indices on iShares and country funds and not the effect of iShares on country funds or vice versa. The only study, to a limited extent, that tries to investigate the latter relationship is Patro (2001). He investigates the effect the listing of iShares has on country funds. However, this study falls short of investigating the short-term and long-term relationships between these assets—the focus of this study.

The above literature along with this study differ from past studies in that they investigate investible assets rather that indices. Regional relationships among indices have been investigated by, among others, Climent, Menue and Pardo (2001), Dekker, Sen, and Young (2001) and Chelly-Steeley, Steeley, and Pentecost (1998). Respectively, these studies find linkages among the regional Asia Pacific markets and between German, Swiss and French markets. While not investigating similar regions, Morck, Young and Yu (2000) suggest that regional markets could be related due to property rights.

Some studies such as Ratanopkorn and Sharma (2002) and Illueca and Lafuente (2002) have not limited themselves to one specific region but have investigated regional relationships throughout the world. They find that the type of relationship changes depending on the time period. No relationships were found during pre-crisis, long-run relationships were found during crisis, and increased short-run relationships were found during post-crisis.

This study does not segregate the data into various time periods but tries to investigate short-term and long-term relationships over the entire time span. It maintains the regional approach, even while considering regions across the world. Thus, it separates itself from studies that investigate relationships across world markets without regional focus such as Hamao, Masulis and Ng (1990). This study's regional approach also excludes the dominant effect that major markets such as Japan and the U.S. have on regional indices as found in Ghosh, Saidi and Johnson (1999) Ng (2000) and Chowdhary (1994). Such an approach helps this study to be applicable to any global investor rather than any single country's investor.

DATA

The iShares and country funds used in this study represent Germany, Spain and Switzerland for Europe and Japan, Malaysia, and Singapore for Asia. The span of this weekly closing price data ranges from March 18, 1996 through August 31, 2004 and includes 433 observations. Lipper provided data for country funds and data for iShares was obtained from Yahoo finance.

iShares started trading on March 18, 1996. Country funds for the countries discussed in this paper have been trading even before that date. However, to be consistent and be able to compare the results of iShares with country funds, the start date of country fund data is also selected as March 18, 1996. There is a possibility that there are multiple country funds trading for the same country. In such cases, the country funds with the longest history are selected. Not all iShares that trade today started trading on March 18, 1996. To incorporate the entire history of iShares (consistent with the longest trading history for country funds), the subset consists of Australia, Austria, Belgium, Canada, France, Germany, Hong Kong, Italy, Japan, Malaysia, Mexico, Netherlands, Singapore, Spain, Sweden, Switzerland, and the U.K. This leads to the selection of Germany (a major economy in the Euro zone), Spain (a relatively smaller economy in the Euro zone), and Switzerland (a non-Euro zone economy). This study differs from previous studies in that it does not include only major economies in Europe, but also looks at the smaller economies in Europe. Though there is no monetary union in Asia, the selection criteria in Asia tries to mimic the one in Europe by selecting Japan, Singapore and Malaysia.

METHODOLOGY

Investigation of long-run relationships using cointegration methodology needs the determination of the presence of unit roots (non-stationarity) of variables. The presence of unit roots is investigated using Dickey Fuller (1981) and Phillips Perrone (1988) tests. The null hypothesis in these tests is the presence of unit roots. Rejection of the null hypothesis indicates stationarity in variables.
Johansen's methodology is used to investigate cointegration among variables. The lag length is chosen such that errors are reduced to white noise based on the Box-Ljung Q-statistic for serial correlation in the residuals. Johansen's trace statistic:

$$\text{Trace statistic} = -T\sum_{i=r+1}^{p}\ln(1-\lambda_i) \qquad (1)$$

and maximum Eigen value test:

$$\lambda_{\max} = -T\ln(1-\lambda_{r+1}) \qquad (2)$$

are used to identify cointegrating vectors. The null hypothesis is that there are at most *r* cointegrating relationships. When either the trace or λ-max statistic is significant, then the null hypothesis is rejected in favor of r+1 cointegrating vectors. In the case where there are two variables, such as the country fund and iShare of a single country, there can be a maximum of two cointegrating vectors. However, in the case of regional relationships, there can be at most three cointegrating vectors. First, the null hypothesis of zero cointegrating vectors is tested. If this is rejected, then there is at least one cointegrating vector. Next, the null hypothesis of one cointegrating vector is tested. This sequential testing is continued until no additional cointegrating vectors are found.

First, the relationship of each country's iShare is investigated with respect to that same country's country fund. Next, the relationship among regional iShares is investigated, followed by that of the relationships among regional country funds. Short-term relationships are investigated using vector autoregression (VAR). Bidirectional causality between the country funds and iShare of the source country are tested by alternatively treating each variable as a dependent variable. To test the effect of the country fund on the iShare of that country, all lags of the country fund are equated to zero. To test the effect of the iShare on the country fund, all the lags of the iShare are equated to zero. If we reject these hypotheses individually, then the country fund affects the iShare and the iShare affects the country fund respectively. The equation is as follows

$$Y_t = \sum_{i=1}^{i=r} Y_{t-i} + \sum_{i=1}^{i=r} X_{t-i} \qquad (3)$$

Where,
Y_t = log returns of dependent variables (iShare/country fund)
X_{t-i} = log returns of independent variables (country fund/iShare)
i = number of lags

To investigate the effect of a country fund (independent) on another country fund (dependent) within that same region, the lags of the independent variable are equated to zero. Rejection of this hypothesis implies an effect of that country fund on the dependent variable. The effect of all other regional country funds taken as group on a particular country fund within that region is investigated by equating the sum of all the lags of these regional country funds (except the lags of the dependent country fund) equal to zero. If this hypothesis is rejected, then all the other country funds of the region as a group affect the country fund in question. The above procedure is repeated for each country fund in either region. Similar tests are also performed for iShares from both the regions. The equation to test these hypotheses is as follows:

$$Y_t = \sum_{i=1}^{i=r} Y_{t-i} + \sum_{n=1,i=1}^{n=k,i=r} X_{n,t-i} \qquad (4)$$

Where,

Y_t = log returns of dependent variables (country fund)
$X_{n,t-i}$ = log returns of independent variables (country fund)
i = number of lags
n = number of countries
Similar tests are also performed for iShares using the same equation with iShares being replaced by country funds.

RESULTS

Long-term Relationships

Variables are investigated for stationarity using Dickey Fuller (1981) and Phillips Perrone (1988) tests. As evident from Table 1, the null hypothesis of presence of unit root cannot be rejected for variables in levels. However, this hypothesis is rejected for variables in first differences. Thus, all variables are I (1).

The possibility of a long-run relationship is investigated using Johansen's cointegration tests. First, long run relationships are investigated between country funds and iShares of a single country. The optimal number of lags are obtained using Box Ljung statistic. Lags are increased until errors are reduced to white noise. Using Johansen's test, cointegrating vector is recognized when at least the λ-max or trace statistic (as described in equations 1 and 2 respectively) is significant and, hence, reject the hypothesis of absence of cointegrating vector. This is a sequential test starting with zero cointegrating vectors. As evident from Table 2, the null hypothesis of zero cointegrating vectors cannot be rejected in the case of the German country fund and iShare. Thus, there is no long-run relationship in the case of Germany. Similar results are found in the case of Switzerland and Spain in Europe.

Table 1: Unit Root Tests in Levels

	Levels		First Difference	
	DFunit	PPunit	DFunit	PPunit
CF Germany	-0.80385	-0.80051	-20.02991*	-20.06540*
CF Spain	-1.49453	-1.40881	-22.35602*	-22.44336*
CF Switzerland	-1.73984	-1.77076	-19.64180*	-19.66226*
CF Japan	-2.31336	-2.27954	-21.55091*	-21.62612*
CF Singapore	-2.27347	-2.26908	-23.75345*	-23.61336*
CF Malaysia	-2.17952	-2.18457	-22.39493*	-22.38174*
IS Germany	-1.47140	-1.48504	-20.91546*	-20.96324*
IS Spain	-2.12440	-2.14917	-21.77813*	-21.80147*
IS Switzerland	-2.18924	-2.13894	-2.18924*	-22.13787*
IS Japan	-1.84002	-1.79083	-23.12280*	-23.12793*
IS Singapore	-2.19116	-2.18854	-22.76928*	-22.73384*
IS Malaysia	-1.90082	-1.98416	-21.49008*	-21.55670*

**1% level of significance*

Table 2: Johansen's Co integration Test Results for Prices of Country Fund and I-Shares of the Individual Countries of Europe and Asia[a,b,c]

	Europe				Asia		
	H0= r	*λ-max*	*Trace*		*H0= r*	*λ -max*	*Trace*
Germany				Japan			
	0	4.18	5.0		0	11.21*	16.64*
	1	0.82	0.82		1	5.43*	5.43*
Spain				Malaysia			
	0	4.58	6.06		0	5.35	7.92
	1	1.48	1.48		1	2.57	2.57
Switzerland				Singapore			
	0	6.10	9.33		0	7.21	12.18
	1	3.23	3.23		1	4.97	4.97

**10% level of significance*

[a]*Johansen's methodology is used to detect the number of cointegrating vectors. The optimal number of lags are obtained using Box Ljung statistic. Lags are increased until errors are reduced to white noise.*

[b]*Cointegrating vector is recognized when at least one of the two statistics reject the hypothesis.*

[c]*This is a sequential test starting with zero cointegrating vectors.*

Asian results also depicted in Table 2 indicate two cointegrating vectors in the case of Japan. However, there is no cointegration in the case of Malaysia and Singapore. Thus, in both Asia and Europe, there is no cointegration and, hence, no long-run relationship among country funds and iShares, except in the case of Japan. Japanese markets have been depressed over the span of the study. This may affect both the iShare and country fund of Japan. This may explain the long-run relationship between the Japanese iShare and country fund. Further investigation is made in the case of long-run relationships among regional iShares and among regional country funds separately.

Results, as indicated in Table 3, show one cointegrating vector among European iShares and one vector among European country funds. The table also indicates that, while there is no cointegration among Asian iShares, there is the presence of one cointegrating vector among Asian country funds. Thus, there is a long-run relationship within European iShares, European country funds and Asian country funds, but no relationship among Asian iShares.

Table 3: Johansen's Co integration Test Results for Europe and Asia[a,b,c]

	Europe			Asia	
Country Fund Prices			Country Fund Prices		
H0= r	*λ -max*	*Trace*	*H0= r*	*λ -max*	*Trace*
0	20.55*	26.40	0	18.15*	29.18*
1	5.18	5.85	1	5.94	11.03
2	0.67	0.67	2	5.09	5.09
i-Share Prices			i-Share Prices		
H0= r	*λ -max*	*Trace*	*H0= r*	*λ -max*	*Trace*
0	17.08*	24.46	0	12.12	19.92
1	6.41	7.38	1	5.57	7.80
2	0.97	0.97	2	2.24	2.24

**10% level of significance*

[a]Johansen's methodology is used to detect the number of cointegrating vectors. The optimal number of lags are obtained using Box Ljung statistic. Lags are increased until errors are reduced to white noise.

[b]Cointegrating vector is recognized when at least one of the two statistics reject the hypothesis of r cointegrating vector(s) in favor of r+1 cointegrating vector(s).

[c]This is a sequential test starting with zero cointegrating vectors.

The above results indicate that, in most cases, in the long run, both iShares and country funds in Asia and Europe are related with regional assets rather than specific country assets. Hence, regional factors play a more significant role than country factors in the long run.

Short-term Relationships

Short-term relationships are investigated beginning with the bidirectional relationship between each country's iShare and country fund and followed by the investigation of regional relationships among iShares and among country funds. VAR is used to analyze the short-run relationship between the dependent and independent variable. The optimal number of lags is such that the errors are reduced to white noise based on Box Ljung statistic.

First, the country fund of a specific country is treated as a dependent variable and the iShare of the same country as the independent variable. Next, the iShare of the same country is treated as the dependent variable while treating the country fund as the independent variable. To test the effect of the independent variable on the dependent variable, all the lags of the dependent variable are equated to zero. If this null hypothesis (i.e., independent variable has no effect on the dependent variable) is rejected, then the dependent variable is affected by the independent variable.
As indicated in Table 4, both the German and Spanish iShares affect their own country funds respectively. However, their country funds do not affect their own respective iShares. Switzerland is the exception in that there is a bidirectional effect between the Swiss country fund and its iShare.

Table 4: Short-run Relationships between Assets of Single Countries of Europe and Asia[a,b,d]

Panel A: Country Fund Prices as Dependent Variables							
	F-Values for Dependent Variables				*F-Values for Dependent Variables*		
Independent Variables[c]	GER	SPA	SWI	Independent Variables[c]	JAP	MAL	SIN
IS GER	7.23***			IS JAP	4.65*		
IS SPA		12.15***		IS MAL		3.18**	
IS SWI			10.95**	IS SIN			1.65
Panel B: iShare Prices as Dependent Variables							
	F-Values for Dependent Variables				*F-Values for Dependent Variables*		
Independent Variables[c]	GER	SPA	SWI	Independent Variables[c]	JAP	MAL	SIN
CF GER	0.55			CF JAP	1.32		
CF SPA		0.83		CF MAL		0.52	
CF SWI			3.39**	CF SIN			1.65

10% level of significance, ** 5% level of significance, * 1% level of significance*

[a]*VAR is used to analyze the short-run relationship between the dependent and independent variable. The optimal number of lags is such that the errors are reduced to white noise based on Box Ljung statistic.*

[b]*This table investigates the bidirectional effect of a single country's iShare and country fund.*

[c]*The null hypothesis that the dependent variable is not affected by the independent variable is tested by equating all the lags of independent variables equal to zero. Rejection of the null would imply the independent variable affects the dependent variable individually.*

[d]*The following abbreviations are use: Germany (GER), Spain (SPA), Switzerland (SWI), Japan (JAP), Malaysia (MAL), Singapore (SIN).*

In the case of Asia, also shown in Table 4, there is an effect from the Japanese iShare to its country fund and from the Malaysian iShare to its country fund. However, there is no effect in the reverse direction for either country. There is no relationship in either direction in the case of Singapore.
Short-term results for each country indicate that there is at least a unidirectional relationship in most cases, with the exception of Singapore.

The individual effect of regional iShares on a specific country's iShare is investigated by equating the lags of individual iShares (independent variable) to zero. The group effect is investigated by equating the sum of the lags of all the country's iShares (except the dependent variable) equal to zero. In Europe, as shown in Table 5, only the Swiss iShare affects the German iShare. There is no other individual relationship from any iShare to another iShare nor is there any group effect on any of the regional iShares, except in the case of Germany.

For country funds, the Swiss country fund individually affects both the German and Spanish iShares. There is no other individual effect. Additionally, there is a group effect from regional country funds on the German and Spanish country funds. Hence, there is a minimal relationship among country funds in Europe in the short run.

Of all the relationships possible among Asian iShares and among Asian country funds, as depicted in Table 5, the only individual effect is that of the Singaporean country fund to the Malaysian country fund. Additionally, the only group effects are found from regional iShares to the Malaysian and Singaporean iShares and from regional country funds to the Malaysian country fund. Thus, there are very few relationships in Asia in iShares or country funds in the short run.

Table 5: Short-Term Regional Relationships among a Single Asset Class of European and Asian Countries[a,b.e]

Panel A: Country Fund Prices							
	F-Values for Dependent Variables				*F-Values for Dependent Variables*		
Independent Variables[c]	GER	SPA	SWI	Independent Variables[c]	JAP	MAL	SIN
CF GER		0.08131	1.34	CF JAP		1.70	1.66
CF SPA	0.20		1.58	CF MAL	0.36		0.13
CF SWI	3.58**	2.65*		CF SIN	1.07	6.12***	
All EURO except dep.	4.77**	6.99***	1.36	All ASIA except dep.	2.33	16.05***	1.20
Panel B: iShare Prices							
	F-Values for Dependent Variables				*F-Values for Dependent Variables*		
Independent Variables[c]	GER	SPA	SWI	Independent Variables[c]	JAP	MAL	SIN
IS GER		0.55	0.13	IS JAP		0.87	1.40
IS SPA	0.02		0.77	IS MAL	1.61		0.43
IS SWI	3.25**	1.75		IS SIN	0.86	1.71	
All EURO except dep.	4.04**	1.44	0.15	All ASIA except dep.	1.02	10.96***	2.77*

** 10% level of significance, ** 5% level of significance, *** 1% level of significance*

[a]VAR is used to analyze the short-run relationship between the dependent and independent variable. The optimal number of lags is such that the errors are reduced to white noise based on Box Ljung statistic.

[c] The null hypothesis that the dependent variable is not affected by the independent variable is tested by equating all the lags of independent variables equal to zero. Rejection of the null would imply the independent variable affects the dependent variable individually.

[d]The null hypothesis that all the independent variables as a group affect the dependent variable is tested by equating the sum of all lags of all variables equal to zero. Rejection of the null would imply that all the independent variables as a group affect the dependent variable.

[e]The following abbreviations are use: Germany (GER), Spain (SPA), Switzerland (SWI), Japan (JAP), Malaysia (MAL), Singapore (SIN).

The above results indicate that the majority of short-term relationships are found between the iShares and country funds of a single country rather than among regional iShares and among regional country funds. These relationships are not a function of a specific region. Thus, it is safe to say that in the short run, individual country effects play a more significant role than regional effects.

Comparing short-term results with long-term results indicates that while short-term relationships are dominated by country relationships (effects), long-term relationships are affected more by regional relationships. These results support the theory that in the short term, country effects are dominant in asset markets of iShares and country funds. However, in the long run, the regional effects are more dominant in the iShare and country fund markets. Thus, investors interested in these assets should be aware of these relationships. This information would help them diversity efficiently depending upon the time horizon of the investment.

CONCLUSION

This paper analyzes the relationships among each country's iShare and country fund and compares these relationships with those found within regional iShares and within regional country funds. Both iShares and country funds represent assets of a single country. By this fact, they should be related to one another.

However, as part of a geographical region, iShares and country funds may also have a regional effect. This study investigates such effects in terms of long run and short-run relationships.

Three countries each from Europe and Asia are investigated for short-term and long-term relationships among iShares and among country funds. In the short run, all countries in Europe and all but Singapore in Asia show relationships among their iShares and country funds. However, in the long run no relationships are maintained. Only in the case of Japan do we see both short-run and long run relationships. In both regions, there are minimal regional effects in the short run. But, long-run regional relationships are formed despite the lack of short-run relationships.

The above results indicate the influence of country factors in the short run and regional factors in the long run. Hence, investors considering investing in these assets should look at the country relationships and regional relationships between these assets. Also, depending on their time horizon, investors should inspect which factor is more relevant.

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BIOGRAPHY

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CANADIAN STOCK SPLITS AND FINANCIAL ANALYST FORECASTS: TESTING SIGNALING AND ATTENTION EFFECTS

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ABSTRACT

This paper analyses Canadian market reaction to stock splits over the period 1985-2000. It then attempts to explain this reaction by two hypotheses, namely signaling and attention hypotheses. Results indicate that the Canadian market reacts positively to stock split announcements. Positive average abnormal returns of 1.76% and 1.14% are reported for the announcement date and the following day, respectively. This market reaction is partly explained by signaling hypothesis. An earning prediction error of 115.05% after the announcement date is observed, giving support to this hypothesis. However, the authors are unable to validate the attention hypothesis in Canadian markets. The average revision rate of earnings per share by financial analysts is 3.49%, but is not significant.

INTRODUCTION

Stock splitting is far from being a marginal phenomenon in Canada. It has increased with time, and is receiving more and more interest from financial analysts and investors. This operation, which increases the number of outstanding shares, decreases the price of each share, but has no effect on shareholders' proportional ownership of shares, should in theory be a purely cosmetic change that has no impact on the splitting firm's value. If the total value is independent of the number of shares outstanding, 100 shares at $5 per share must give the same total value as 500 shares at $1 per share. However, empirical studies usually show that a stock split is far from being a purely cosmetic event. They report a positive market reaction to stock split announcements, thus creating a conflict between theory and practice.

There are several papers on US market reactions to stock splits, but few on Canadian market reactions (papers on Canadian markets include Charest, 1980; Kryzanowski & Zhang, 1991, 1993, 1996; Masse, Hanrahan & Kushner, 1997; and Elfakhani & Lung, 2003). Moreover, with the exception of Kryzanowski and Zhang (1996) and Elfakhani and Lung (2003), these Canadian studies do not provide explanations for the positive market reaction surrounding stock split announcements, the interest of the present paper. This paper's concern with analysis of Canadian market reaction to stock split announcements also derives from differences between US and Canadian financial markets. Canadian exchanges are proportionately smaller than US exchanges and many firms are thinly traded small stocks. Additionally, there are different capital gain tax laws in Canada. These factors may affect the way investors react to stock split events. Over a period not covered by previous studies (1985 to 2000), the presence of positive abnormal returns following stock split announcements by Canadian firms listed on the Toronto Stock Exchange (TSE) is tested. Then, the authors try to explain the market reaction (if any) using signaling and attention hypotheses.

Results indicate that Canadian markets react positively to stock split announcements. On average, firms splitting their stock record a 1.76% positive and significant abnormal return on the announcement date, and 1.14% on the following day. An earning prediction error of about 115.05% after the split is also observed. This validates signaling hypothesis, which states that firms split their stock to signal superior earnings. However, the authors are unable to validate attention hypothesis in Canadian markets. The

average revision rate of earnings per share by financial analysts is 3.49% for splitting firms, but is not significant.
The paper continues as follows: Section 2 briefly reviews existing literature on stock splits. Section 3 formulates hypotheses and describes our data and methodology. Results are presented and discussed in Section 4, and Section 5 concludes our study.

LITERATURE

Market reaction to stock splits has been discussed intensively in the financial literature. It is generally agreed that financial markets react positively to split announcements. In US markets, Grinblatt, Masulis and Titman (1984), Lamoureux and Poon (1987), and Rankin and Stice (1997) report short-term positive and significant market reaction, while Ikenberry, Rankin and Stice (1996), Desai and Jain (1997) and Byun & Rozeff (2003) find a long-term reaction to stock splits. In a Canadian market, Charest (1980) has found that split stocks traded on the TSE during the period 1963-1975 outperformed the market by 59% in the pre-split announcement months, but barely matched the market in year 1 and lost 7% in year 2. Kryzanowski and Zhang (1991) find a positive and significant mean abnormal return of 0.74% on the split proposal date over the period 1978-1987, but a non-significant abnormal return over the approval date. Kryzanowski and Zhang (1993) report a positive and significant mean abnormal return on the split ex-date using traditional event-study techniques, but this becomes insignificant after applying conditional residual variances modeled using various ARCH processes. Finally, Elfakhani and Lung (2003) find a positive and significant mean abnormal return in Canada during the period 1977-1993.

While several hypotheses have been advanced to explain financial markets' reaction to stock splits, they can be broadly classified into two groups: optimal price and signaling.

According to the optimal price (or optimal trading range) hypothesis, a stock split realigns a stock price with a "trading range" preferred by investors, thereby increasing transaction volumes and liquidity. Higher stock prices preclude some investors (usually small investors) from buying a stock. A stock split moves the stock price into a more desirable trading range. Decreased stock price makes the stock more attractive for a large number of investors (the optimal trading price results from an arbitrage between a low price, preferred by small investors, and a high price, which decreases the unit transaction cost for large investors). Maloney and Mulherin (1992) report an increase in transaction volume, a decrease in the bid-ask spread, and an increase in the number of shareholders and institutional investors following the stock split. McNichols and Dravid (1990) provide strong evidence for the trading range hypothesis and a positive relationship between returns and split factors. Lakonishok and Lev (1987) also support the trading range hypothesis. Some authors, however, find that the liquidity of split stocks decreases. Copeland (1979) finds a decrease in trading volume and an increase in both brokerage costs and bid-ask spread after the split. Lamoureux and Poon (1987) also find that liquidity is reduced by a split and increased by a reverse split. In Canada, dichotomizing trade by size, Kryzanowski and Zhang (1996) report that small firms benefit from stock splits in terms of enhanced marketability and lower liquidity premium. This is not the case for larger traders. Elfakhani and Lung (2003) find support for the trading range hypothesis and increased liquidity in Canada over the period 1977-1993.

Signaling hypothesis presumes that managers know more about the value of their firm than investors and use stock split to convey favorable information to the latter. Stock splitting, then, is a device for managers to signal their highest earnings potential to financial markets. Brennan and Copeland (1988) find that in cases where expensive signaling is used to convey credible information to investors, stock splits explain about 27% of abnormal returns. McNichols and Dravid (1990) also support signaling hypothesis and find a positive correlation between abnormal returns and the split ratio. Doran (1995) finds that following the split event, earnings significantly exceed analysts' earnings forecasts, suggesting that the split event signal represents valuable information about future favorable earnings. US evidence on signaling hypothesis includes Lakonishok and Lev (1987), and Crawford and Franz (2001). In Canada, there is no clear evidence regarding signaling effects. Although Elfakhani and Lung's (2003) conclusions support signaling hypothesis over the period 1977-1993, their test is very weak. Specifically, they report that "earnings per share do increase after the stock split announcement but not significantly. Thus, the earnings results must be interpreted with caution" (page 210).

HYPOTHESES, DATA AND METHODOLOGY

Three hypotheses are tested in this article:

The first hypothesis concerns the informational content of stock splits. It states that stock splits are good news for financial markets. Consequently, firms that split their stock record a positive abnormal return around the announcement date. This hypothesis is formulated as follows:

Hypothesis 1: Canadian financial markets positively react to stock split announcements.

The second hypothesis tests the signaling effect of stock splits. It is based on the presumption that managers know more about the value of their firms than investors. The asymmetric information between these two parties forces managers to use financial decisions such as stock splits to convey favorable information to investors. Stock splits are a device for managers to signal higher earnings potential relative to analysts' forecasts.

Thus, Hypothesis 2 states the following:

Hypothesis 2: Firms splitting their stock record positive earnings prediction error after the announcement date.

The attention hypothesis is a special version of signaling theories. It maintains that managers announce a stock split to attract the attention of financial analysts, which leads to a reassessment of the firm's future cash flow. Based on this presumption, Hypothesis 3 is formulated as follows:

Hypothesis 3 There is an upward revision of split earning forecasts by financial analysts after the announcement date.

This study covers 16-year running from 1985 to 2000. All stock split executions reported in the *Toronto Stock Exchange Monthly Review* over the study period are identified. 458 splits made by 398 firms are obtained. Next, *The Globe and Mail, Financial Post,* and *Canadian Business Index* are used to identify stock split announcement dates. From the 458 observations 160 splits are excluded because the exact announcement dates was not identified. 95 observations from firms with a split ratio lower than 25% or simultaneously announcing other events able to induce market reaction (dividend increases or decreases, divulging of results, sales forecast updates, merger and acquisition announcements) are also excluded. After these adjustments, 203 stock split announcements free from any "contaminating" effect are used in this study. Stock returns is collected from *Datastream,* and of the 203 announcements, complete data on both dividend adjusted returns, firm size and SIC code for 119 announcements is obtained. These 119 observations (hereafter labeled a complete test sample) are used to test the first hypothesis.

To create samples for Hypotheses 2 and 3, the authors retrieve financial analyst earning forecasts from *IBES Canada Database*. To be included in the test sample, firms need to be followed by at least three financial analysts before the split announcement date. This leads to a reduced test sample of 43 observations to be used in these two hypotheses (hereafter labeled test sample). A control sample of 46 non-splitting firms is used to control for possible size and industry effects. This is done by matching every company that had a stock split announcement to a non-splitting firm from the same industry (based on the Standard Industrial Classification (SIC) code) with an asset value that is as close as possible to the splitting company's asset value. Following Lakonishok and Lev (1987), total assets are preferred as the size measure over the market value of equity, because in the period preceding the announcement of splits there is usually a substantial increase in the market value of stocks. The following market model is used to generate expected returns which will later be used to compute event day abnormal returns:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}, \tag{1}$$

where

R_{it} is the realized return of stock i on day t, R_{mt} is the market portfolio return (the Toronto stock index) on day t, α_i and β_i are coefficients to be estimated and ε_{it} is the error term.

Parameters are estimated with ordinary least square. However, when preliminary tests indicate that return series are autocorrelated and heteroscedastic, AR (p) or GARCH (p,q) model is used.

The window used to estimate Equation (1) parameters ranges from day -60 to day -4 before the split announcement date, while the event window is represented by days -3, -2, -1, 0, 1, 2, and 3, with day 0 as the announcement day. Of particularly interest is day t = 0 and t = 1, since stock split announcements become public information a day after their official announcement.

Firm i abnormal return on event day t is given by:

$$A_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt}), \tag{2}$$

where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are coefficients to be estimated from Equation (1).

Following Brown and Warner (1985), when abnormal returns are normally distributed, for each event day (t = -3, -2, -1, 0, 1, 2, 3), whether they were significantly different from zero is checked using the following student test:

$$T_{statistic} = \overline{A}_t / \hat{s}(\overline{A}_t), \tag{3}$$

where the mean and the standard deviation of mean abnormal returns are respectively given by:

$$\overline{A}_t = \frac{1}{N}\sum_{i=1}^{N}(A_{it}),$$ with N representing the sample size,

$$\hat{s}\left(\overline{A}_t\right) = \sqrt{\frac{1}{56}\sum_{t=-60}^{-4}(\overline{A}_t - \overline{\overline{A}}_t)^2}, \quad \text{with} \quad \overline{\overline{A}}_t = \frac{1}{57}\sum_{t=-60}^{-4}\overline{A}_t$$

However, when abnormal returns are not normally distributed, non-parametric tests such as the sign test and the Wilcoxon test is used to check whether or not their mean value is statistically different from zero.

To test for the presence of the signaling effect formulated in Hypothesis 2, the earning prediction error for both splitting and non-splitting firms as follows are computed:

$$EPE_i(\%) = \left[AEPS_i - CEPS_i\right] / \left|CEPS_i\right|, \tag{4}$$

Where

EPE_i is the firm i earning prediction error (in percentage) after the announcement date, $AEPS_i$ is firm i observed earnings per share in the announcement year and CEPS is the consensus formed by financial analysts on firm i earning per share before the announcement date for the announcement year. *IBES Canada* provides both earnings per share -EPS- forecasts for individual financial analysts and mean EPS forecasts for all financial analysts following a stock. To form a financial analyst consensus in the EPS forecast, the median of individual EPS forecasts is used).

For both the test and the control samples, the mean EPE is computed and the Wilcoxon test is used to assess if it is positive and significant. For splitting firms, a positive and significant mean EPE is anticipated.

Further, for each pair of firms drawn from the two samples, the difference in EPE (D_EPE) is computed and is tested if its mean is significantly different from zero. A positive and significant value for mean D_EPE is anticipated.

$$D\_EPE_i = EPE_i(Test) - EPE_i(Control) \qquad (5)$$

To test for the presence of the attention effect formulated in Hypothesis 3, the revision of earnings per share by financial analysts for both splitting and non-splitting firms is computed as follows:

$$REVISION_i(\%) = \left[CEPSafter_i - CEPSbefore_i\right] / CEPSbefore_i, \qquad (6)$$

Where

$REVISION_i$ refers to the revision (in percentage) of firm i earnings per share by financial analysts, and CEPS is the consensus formed by financial analysts on firm i earnings per share.

For both samples, the mean REVISION is computed and the Wilcoxon test is used to assess if it is positive and significant. For splitting firms, a positive and significant mean REVISION is anticipated. Further, for each pair of firms drawn from the two samples, the difference in REVISION (D_REVISION) is computed and is tested whether its mean is significantly different from zero. A positive and significant value for mean D_REVISION is anticipated.

$$D\_REVISION_i = REVISION_i(Test) - REVISION_i(Control) \qquad (7)$$

RESULTS AND ANALYSES

Descriptive Statistics

Table 1 presents the distribution of the 458 stock splits recorded over the period 1985-2000. Notice that 92% of them are large splits and that the split ratio is generally around 2 to 1.

Table 2 reports statistics on the test and control samples. The statistics presented for the test sample are related the 46 observations used to test Hypotheses 2 and 3. Although the complete test sample includes 119 observations, reduced test sample statistics are used in order to compare them with those of the control sample.

Table 1: Distribution of Stock Splits in Canada During the Period 1985-2000

Large splits (higher than 100%)			Low splits (between 25 and 100%)		
Ratio	Number	Percentage	Ratio	Number	Percentage
2:1	319	69.65	3:2	34	7.42
3:1	76	16.59	5:4	2	0.44
4:1	10	2.18	4:3	1	0.22
5:1	8	1.75			
6:1	3	0.66			
10:1	3	0.66			
7:1	2	0.44			
Total	421	92	Total	37	8

The mean and median sizes of the test sample are slightly higher than those of the control sample. For earnings per share, the two samples have an almost identical mean. Conversely, the control sample has a higher median earnings per share. On the other hand, the average number of financial analysts following firms in the test sample is almost the same as in the control sample.

Table 2: Sample Characteristics

	Total assets*	EPS*	Number of Financial Analysts
Test sample			
Mean	9,641,037	0.52	10.02
Median	420,810	0.32	6.50
Control sample			
Mean	7,294,631	0.60	9.24
Median	307,848	0.55	7.50

* Total assets and earnings per share (EPS) are expressed in Canadian dollars.

Table 3 reports descriptive statistics on abnormal returns for –3 to +3 event days. It is evident that abnormal returns are not normally distributed. In all event days, their skewness is different from zero. Their kurtosis is also larger than 3, which may signal the presence of extreme values. Consequently, non-parametric tests in the hypotheses tests are used.

Table 3: Distribution of Abnormal Returns

	Day						
Statistics	-3	-2	–1	0	+ 1	+2	+3
Minimum	-0.086	-0.127	-0.214	-0.091	-0.098	-0.065	-0.007
Maximum	0.106	0.138	0.099	0.201	0.147	0.123	0.011
Mean	0.003	0.03	0.001	0.017	0.011	0.003	0.002
Median	0.001	0.0009	0.0002	0.008	0.006	-0.001	0.000
Standard dev.	0.024	0.031	0.034	0.041	0.035	0.029	0.027
Skewness	0.789	0.205	-1.815	1.427	0.845	1.179	0.057
Kurtosis	6.712	9.755	15.893	6.850	5.472	6.039	5.482
Jarque-Bera Stat.	80.684	227.10	889.63	113.90	44.472	73.389	36.969
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Market Reaction to Stock Split Announcements (Hypothesis 1)

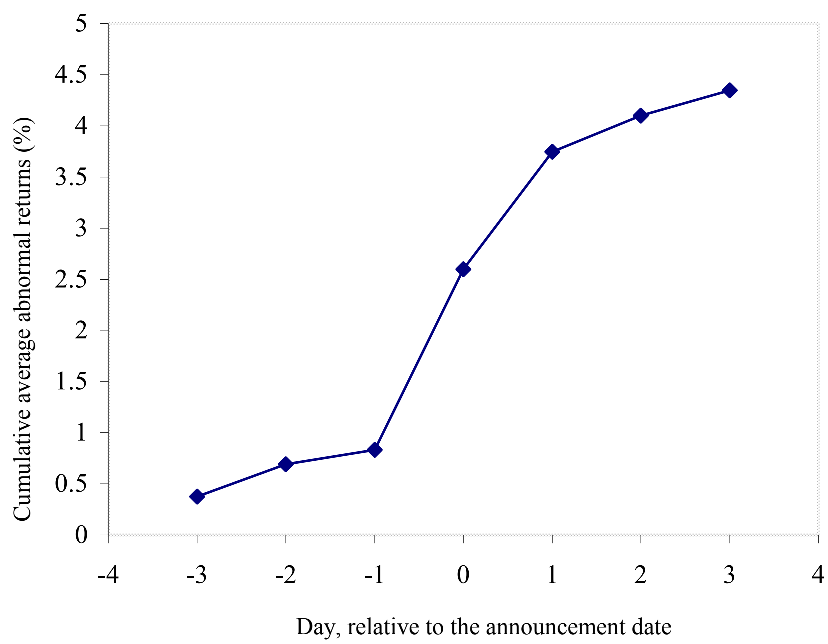
Table 4 reports an average positive abnormal return of 1.76% on the stock split announcement date and 1.14% the day after. Both the sign test and Wilcoxon test show that these average abnormal returns are statistically different from zero at a 5% level. For the other event dates, abnormal returns are not significantly different from zero at a 5% level. This validates our first hypothesis, which states that Canadian markets react positively to stock split announcements. It also confirms results previously found by some Canadian studies using different periods (see, for instance, Kryzanowski & Zhang 1991; Elfakhani & Lung, 2003).

Table 4: Non-parametric tests for market reaction to stock splits

Event date	Mean Abnormal Return (%)	Sign Test				Wilcoxon Test	
		Z-statistic	P-value	$A_{it} > 0$	$A_{it} < 0$	Z-statistic	P-value
T=-3	0.37	0.92	0.36	65	54	1.19	0.23
T=-2	0.31	0.91	0.35	65	54	1.38	0.16
T=-1	0.14	0.18	0.85	61	58	0.55	0.58
T=0	**1.76**	**3.48**	**0.00**	**79**	**40**	**4.40**	**0.00**
T=1	**1.14**	**2.56**	**0.10**	**74**	**45**	**3.17**	**0.001**
T=2	0.35	1.83	0.06	49	70	0.01	0.98
T=3	0.24	0.00	1.00	59	60	0.79	0.42

Figure 1 presents the cumulative mean abnormal return over the event period (days -3 to +3).

Figure 1: Evolution of Cumulative Abnormal Returns for the Six Days Surrounding the Split Announcement Date



Notice from this figure a positive cumulative abnormal returns from t = -1 to t = +1, which tends to become stable after the stock split announcement (precisely after day 1). This clearly associates abnormal returns with stock split announcements.

Existence of a Signaling Effect (Hypothesis 2)

For both splitting and non-splitting firms, the earning prediction error after the stock split announcement is computed. The results reported in Table 5 following indicate the presence of a mean earning prediction error of 115.05% for the test sample and 0.53% for the control sample. The test sample mean average earning prediction error is statistically different from zero, though this is not the case for the control sample. Moreover, the difference in mean earning prediction error between the two samples is positive (i.e., is higher for firms announcing a stock split).

Table 5: Wilcoxon test for earnings prediction error after announcement date

	Mean EPE (%)	**Z-statistic**	**P-value**
Reduced sample	115.05	3.977	0.0001
Control sample	53.61	0.767	0.9056
Difference in EPE (%)	61.44	0.994	0.320

These results validate Hypothesis 2 which states that splitting firms record surprisingly positive earnings per share. This allows us to partially explain the positive reaction of Canadian markets to stock splits by the signaling effect, and reinforces results found in Canadian markets by Elfakhani and Lung, (2003). It also confirms those found in US markets. Doran (1994) reports that in the US, firms announcing a stock split record a positive and significant earning prediction error of 22.9 %. Ye (1999) also found positive and significant earning prediction error in US markets on event days.

Existence of an Attention Effect (Hypothesis 3)

For both splitting and non-splitting firms, the revision of earnings forecast by financial analysts after the stock split announcement is computed. The results reported in the following Table 6 indicate that the mean revision of earnings per share forecasts by financial analysts is not significantly different from zero for both samples. There is an upward (but non-significant) revision of forecast earnings per share of 3.49% for splitting firms and a downward (but non-significant) revision of forecast earnings per share of 2.51% for the control sample. The 6% mean difference revision between the two samples is also not significantly different from zero at a 5% level. Consequently, Hypothesis 3 cannot be validated. This result contrasts with those reported in empirical studies of US markets. Klein and Peterson (1989) and Doran (1994), respectively, found a positive and significant 1.6% and 8.5% revision of forecast earnings per share by financial analysts for splitting firms.

Table 6: Wilcoxon test for financial analysts' revision of forecast earnings per share

	Mean Revision (%)	**Z-statistic**	**P-value**
Reduced sample	3.49	1.352	0.176
Control sample	-2.51	-1.192	0.233
Difference in revision (%)	5.99	1.579	0.114

CONCLUSION

The aim of this paper was primarily to test the existence of a positive market reaction to stock split announcements by Canadian firms over the period 1985-2000 (which is different from the periods used in previous Canadian studies), and next, to attempt to explain an eventual positive market reaction using signaling and attention effects.

Results confirm those found in previous Canadian studies. Positive and significant average abnormal returns of 1.76% and 1.14% for the announcement date and the following day, respectively is found.

The test of the signaling effect hypothesis partially explains this market reaction. Managers seem to split their stock in order to signal higher earnings to financial markets. However, they are unable catch the attention of financial analysts, since these analysts do not adjust (upward) their forecast earnings per share after the split. Thus, the authors cannot validate the attention effect hypothesis in the Canadian market.

The results found in this paper are globally interesting in that they confirm those found in previous Canadian and US studies.

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THE RATIONALITY OF THE COLOMBIAN EXCHANGE MARKET

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ABSTRACT

This research analyzes the way agents participating in the Colombian exchange market form their expectations and how they arrive at an equilibrium price. The forward exchange rate was used as an approximation of the expected spot rate, implying the necessity to explain how its price is determined. Monte–Carlo techniques and three tests of the Forward Foreign Exchange Market Efficiency Hypothesis are conducted. Six hypotheses of behavior were tested, from static to rational expectations and from risk neutrality to risk premium and/or transaction costs. Weekly data from January 1997 to January 2006 presented signs of rational and adaptative expectations, together with risk neutrality.

INTRODUCTION

The tendency to promote a prosperous environment aimed at economic growth has become more pronounced during the last few years as worldwide economic integration has become consolidated. A series of events has confirmed this issue, such as the signing of commercial, scientific and technological cooperation agreements and internal norms being brought into line with international ones.

Colombia opened its capital account and reduced import barriers during the early 1990s. During this same period, the Banco de la República (BR), the country's monetary regulating authority, authorized exchange-rate cover operations for the Colombian peso - US dollar. By doing this, the BR tried to reduce exchange rate volatility and protect market participants.

Forward foreign exchange contracts involve two parties who agree to conduct transactions in foreign currency at an agreed exchange rate for a specified amount at some agreed future date. A forward contract eliminates the effect of future fluctuations on foreign exchange transfer rate. The forward exchange rate is calculated by using the current exchange and interest rates for both currencies and the contract maturity. Fulfilling the covered and uncovered parity condition of interest reveals a close relationship between spot and forward rates. If the Forward Foreign Exchange Market Efficiency Hypothesis (FMEH) holds under the assumption that agents have rational expectations and are neutral towards risk, the forward rate is an unbiased exchange rate predictor corresponding to the date of a contract's maturity. Thus the information contained in the agreed rate in the contracts for future delivery could be useful for predicting fluctuations in the Colombian exchange rate.

This study tries to determine whether some relationship exists between Colombia's forward and spot markets, assuming the rational behavior of agents participating in the exchange market and considering the implicit risk in forward contracts. Therefore, this article could be useful for those who participate in the exchange market or can be directly or indirectly affected by its dynamics. Market participants might use the information contained in the forward exchange rate for their own benefit without becoming involved in problems associated with drawing up complex prediction models and handling a wide-ranging database.

LITERATURE REVIEW

Economic theory starts with the study of agents' behavior patterns when faced with certain circumstances. The concept of rationality, understood as being people's reasoning ability for making decisions, must be considered for generalizing such conduct. Such disposition allows markets and the economy as a whole to make logical distinctions between the most and the least desired outcomes for each agent.

In the case of agents' order of preference and the psychological reasons surrounding their decisions, Bossert *et al.* (2005) and Cosmides & Tobby (1994) have shown that an element maximizes preferences, following natural selection processes until instinctively arriving at optimal situations. By contrast, the work of Haltiwanger & Waldman (1985) and Lovell (1986) have suggested that agents' rationality does not necessarily imply maximizing their utility levels because processing information cannot be related to rational action.

The concept of rationality can also be applied to processing information. If the evolution of economic variables follows a path and not just a random pattern, it is plausible to identify such behavior in generating expectations about future values. Agents must therefore be able to produce prediction models using all important and available information at a certain point in time, thereby implying continuous revision of predictions (and errors made in such predictions) to avoid making systematic errors.

Regarding handling exchange market information, Baillie *et al*. (1983) and Duarte & Stockman (2005) state that agents behave rationally and are risk-neutral as long as the exchange market remains efficient; however, they could change their rational beliefs associated with future exchange rate gains if additional information were available. Obstfeld (2005) has criticized models supposing homogenous agents, rational expectations, and complete markets, emphasizing levels of risk aversion and information asymmetry.

Simultaneously analyzing spot and forward exchange markets, Echols & Elliott (1976), Hsieh (1982), and Barnhart & Szakmary (1991) have shown that models must include terms relating the exchange rate's past and present behavior to verify agents' rationality associated with exchange rate expectation to avoid unit root problems between the spot and forward series.

Speculation and equilibrium prices are also related to forward rate behavior, a subject dealt with by Siegel (1972) and Radalj (2002) who found that speculation and variation in interest rate affected forward rate behavior. They concluded that agents assumed a level of risk if there were a lack of information and that variables did not tend towards equilibrium.

Zietz (1995) performed Monte–Carlo and linear regression experiments to verify efficiency and rational expectations in the forward market, finding that the authorities' intervention in the monetary market obeyed rational behavior and was compatible with covered interest rate parity, as stated by Rozen (1965). Nevertheless, the static expectations' hypothesis without risk premium was not rejected, as were expectations producing exchange market process and equilibrium.

Jeong & Maddala (1991), Cavaglia *et al*. (1994) and Corbae *et al*. (1992) have all rejected the rational expectations hypothesis, the first two groups using primary sources and the latter using market information. Cavaglia *et al*. (1994) and Corbae *et al*. (1992) have all tested risk premium, contradicting exchange market efficiency.

Rationality and Efficiency in the Exchange Market

If the rational expectations hypothesis for an effective rate on the spot exchange market is fulfilled for period $t+k$ (s_{t+k}), then agents form their expectations in the following manner:

$$s_{t+k} = E_t\left(s_{t+k} \middle| I_t\right) + \varepsilon_{t+k} \tag{1}$$

Where $E_t(\bullet)$ is the conditional expectation given all information I during period t and ε_{t+k} is the prediction error. This must fulfill conditions regarding lack of orthogonal [$E\left(\varepsilon_{t+i}\varepsilon_{t+j}\right) = 0, \quad i \neq j$] bias [$E\left(\varepsilon_{t+k}\right) = 0$], respecting information [$E\left(\varepsilon_{t+k} I_t\right) = 0$].

Aggarwal *et al*. (1995) stated that the rational expectations hypothesis could be tested in two ways; some authors use assets for measuring expectations (indirect tests) whereas others construct the hypothesis by means of surveys (direct tests) [a compilation of empirical evidence regarding direct tests can be found in Lovell (1986), Zarnovitz (1985), and Maddala (1990)]. In the first case, not only agents' rationality is tested but also how asset price is determined (market equilibrium).

The forward rate is used in this work as the expectation of the respective future spot exchange rate, supposing that covered and uncovered parity of interests is fulfilled. It is thus necessary to determine how equilibrium in the forward market can be achieved.

If risk is considered in the value of the forward rate, then investors demand a greater return on their investment [i.e. a premium (pr^e) for facing greater variability in the profit which they expect to earn]. According to results found by Grauer *et al*. (1976) and Stockman (1978), the forward rate fixed during period t, expiring during period $t+k$ is thus be equal to:

$$f_{t,t+k} = E_t\left(s_{t+k}\right) + pr_t^e, \quad \text{where } pr_t^e = f_{t,t+k} - E_t\left(s_{t+k}\right) \tag{2}$$

Risk aversion transforms the forward rate into a biased predictor of future spot exchange rate [i.e. one of the conditions of rationality would not be fulfilled as the risk premium is predictable with the present information]. Nevertheless, in the case where agents are risk-neutral [for example, if there is a sufficiently great number of risk-neutral agents or if the exchange risk is perfectly diversifiable] then consecutive deviations would not be committed if the forward rate were chosen to be a prognostic measurement of the spot exchange rate:

$$f_{t,t+k} = E_t\left(s_{t+k}\right) \tag{3}$$

Consequently, if the three conditions are united, the futures' market is efficient. The forward rate accurately predicts the spot rate and both rates quickly correct their values faced with any new relevant information:

$$s_{t+k} = f_{t,t+k} + \varepsilon_{t+k} \tag{4}$$

The last theory is known as the Forward Foreign Exchange Market Efficiency Hypothesis (FMEH), also known as the Forward Rate Unbiasedness Hypothesis (FRUH). If FMEH is not fulfilled, it might be that condition (1) or condition (3) is not being satisfied. The expectations model $E_t(\bullet)$ or the agents' claim for a risk premium is thereby rejected.

Risk Premium and Transaction Costs

Some models containing risk premium components, such as those used by Engel (1995), have shown that forward rate profits may not satisfy the condition of lack of bias due to forward contracts being conditioned to an adjacent asset (spot exchange rate). This is why variation in the expected value of the forward rate can be explained by present risk involved in exchange rate gain and a negative correlation between the discount rate of the forward rate; exchange rate variation may also appear.

In line with the above results, but including variation on time and its negative relationship with interest rate, Hodrick & Srivastava (1983) and Bansal (1997) have stated that the risk involved in profit can display variation in time, depending on interest rate variation, and may be due to the presence of heteroskedasticity in the models. Different tests must thus be designed with variation in the estimated parameters and the presence of heteroskedasticity.

Changes in time have been analyzed by Sakoulis & Zivot (1999), beginning with random walk models, leading to simulations where the absence of risk in exchange rate is allowed only if there are no structural changes in the forward series. It must also be considered that financial market participants are heterogeneous, allowing them to form expectations about inflation and profits in any contract different time stipulation.

Another aspect related to profits in exchange market contracts deals with assumed transaction costs at the time of negotiating with different financial intermediaries; this subject has been treated by Mark & Wu (1998) and Buser *et al*. (1996) when constructing optimal price models and estimating future exchange rate predictors from the present rate. Covered interest rate parity deviation in such models considers covariance between the marginal rate of the substitution of money and present value in forward contract speculation. The implicit value in transaction costs, as stated in their work, can lead agents to deciding between taking a forward contract or an asset on the exchange market; predicting the forward exchange rate assumes transaction costs based on interest rates and exchange rate trend.

METHODOLOGY

A Monte Carlo experiment was performed, following Zietz's methodology (1995), to separate assumptions about exchange market equilibrium from agents' expectations. Monte Carlo methodology leads to interpreting estimations used for verifying FMEH, explaining whether results found are inline with the expectation theories so presented. This is why a data generating process must be chosen which agrees with the estimated parameters and satisfies proposed equilibrium conditions and expectations.

This exercise ranges from the basic case (static expectations) to more complex ones (rational expectations, risk premium and transaction costs). The six cases considered in this document are presented in Table 1. The first type of hypothesis uses static expectations where the forward rate is equal to the spot rate's current value. In this case, no more information is necessary because the present rate contains the necessary information for predicting the future exchange rate [i.e. it follows a random walk].

Unlike the first model, the second model handles the concept of rational expectations. It not only uses the information contained in the current spot rate but also all available and relevant information for making the calculation. The third model includes an intermediate measurement between rational expectations and static ones, in which agents consider different prediction functions.

Up to this point, the models have not considered bias between expected and observed value in the exchange market. This can be associated with two causes: risk and/or costs involved in participating in the market. The fourth model includes rational expectations and risk premium, the latter interpreted as being spot rate coefficient of variation. The fifth model measures transaction costs as a portion of the amount of forwards transacted. The last case is a combination of simulations four and five.

Table 1: Monte – Carlo Simulations

Hypotheses	Expectations	Equilibrium Condition	Simulated Forward Rate
1	Static	Risk neutrality	$f_{t,t+k} = E_t\left(s_{t+k}\right) = s_t + \varepsilon_{1,t}$ $\varepsilon_{1,t} \sim N\left(0,\sigma_1^2\right)$
2	Rational	Risk neutrality	$f_{t,t+k} = E_t\left(s_{t+k}\right) = s_{t+k} - \varepsilon_{2,t+k}$ $\varepsilon_{2,t} \sim N\left(0,\sigma_2^2\right)$
3	Static – Rational	Risk neutrality	$f_{t,t+k} = E_t\left(s_{t+k}\right) = \omega\left(s_t + \varepsilon_{3.1,t}\right) + \left(1-\omega\right)\left(s_{t+k} - \varepsilon_{3.2,t+k}\right)$ $\omega \in \left(0,1\right)$ $\varepsilon_{3.1,t} \sim N\left(0,\sigma_{3.1}^2\right)$ $\varepsilon_{3.2,t} \sim N\left(0,\sigma_{3.2}^2\right)$
4	Rational	Risk premium	$f_{t,t+k} = E_t(s_{t+k}) + pr_t^e = s_{t+k} + pr_t^e - \varepsilon_{4,t+k}$ $pr_t^e = \psi_4 cv_t$ $\psi_4 > 0$ $\varepsilon_{4,t} \sim N(0,\sigma_4^2)$
5	Rational	Transaction costs	$f_{t,t+k} = E_t(s_{t+k}) + ct_t = s_{t+k} + ct_t - \varepsilon_{5,t+k}$ $ct_t = \delta_5 m_t$ $\delta_5 \in \left(0,1\right]$ $\varepsilon_{5,t} \sim N(0,\sigma_5^2)$
6	Rational	Risk premium – transaction costs	$f_{t,t+k} = E_t(s_{t+k}) + pr_t^e + ct_t = s_{t+k} + pr_t^e + ct_t - \varepsilon_{6,t+k}$ $pr_t^e = \psi_6 cv_t$ $ct_t = \delta_6 m_t$ $\psi_6 > 0$ $\delta_6 \in \left(0,1\right]$ $\varepsilon_{6,t} \sim N(0,\sigma_6^2)$

Note: In order to make the simulations, logarithms of all the variables were used $\left(s, f, cv, m\right)$

The previous hypotheses about how asset price is determined were tested by using the three estimations conventionally used for verifying FMEH (co-integration, differences and error correction). Table 2 shows the specification and assumptions of the three econometric models and some articles that test them.

Some dispersion measurements [norm, bias, and mean squared error (MSE)] were used for identifying similarity between simulated results and estimated ones to determine which hypothesis best adjusts to agents' behavior within this market.

Table 2: Estimations Used for Verifying FMEH

Estimation Commonly Used	**H_0: FMEH holds if**	**Some Articles**	**FMEH Holds**
Long run (cointegration)			
$s_{t+k} = \alpha_0 + \alpha_1 f_{t,t+k} + v_{t+k}$	s_{t+k} and $f_{t,t+k}$ are from the same integration level. $\alpha_0 = 0$ and $\alpha_1 = 1$. v_{t+k} is white noise.	Cornell (1977), Levich (1979), Frenkel (1980, 1981), Edwards (1983), Chiang, T.C. (1988), Luintel & Paudyal (1998), Barkoulas *et al.* (2003), Delcoure *et al.* (2003)	Yes
Short run (differences)			
$s_{t+k} - s_t = \beta_0 + \beta_1 (f_{t,t+k} - s_t) + \upsilon_{t+k}$	$\beta_0 = 0$ $\beta_1 = 1$ $E(\mu_{t+k}) = 0$	Cornell (1977), Geweke & Feige (1979), Tryon (1979), Hansen & Hodrick (1980), Bilson (1981), Hakkio (1981), Meese & Singleton (1982), Cumby & Obstfeld (1981, 1984), Fama (1984)	No
Short and long run (error correction)			
$\Delta s_{t+k} = \lambda_0 + \lambda_1 \hat{v}_{t+k-1} + \sum_{j=1}^{J} \lambda_{j+1} \Delta f_{t-j,t+k-j} + \sum_{j=1}^{J} \lambda_{J+1} \Delta s_{t+k-j} + \xi_{t+k}$ $\hat{v}_{t+k-1} = s_{t+k-1} - \hat{\alpha}_0 - \hat{\alpha}_1 f_{t-1,t+k-1}$	$\lambda_0 = 0$ $-\lambda_1 = \lambda_2 = 1$ $\lambda_3 = \ldots = \lambda_{2J} = 0$	Hakkio & Rush (1989), Barnhart & Szakmary (1991), Naka & Whitney (1995), Zivot (2000)	Mixed results

Note: In order to make the estimations, logarithms of all the variables were used (s, f)

A database of weekly observations for the period of January 10 1997 to January 20 2006 was used in this research; all the information came from the BR, especially from the Operations and Market Development Division. The following variables were used for the proposed exercise:

$s_{sem:t}$: Logarithm of Colombian representative US dollar exchange rate, weekly average.

$f_{sem:t,t+1}$: Logarithm of forward exchange rate for weekly contracts, weekly average.

$cv_{sem:t}$: Logarithm of coefficient of variation for the representative exchange rate, weekly average.

$m_{sem:t}$: Logarithm of weekly transacted amount in forward contracts, weekly maturity.

The Monte Carlo experiment was repeated 500 times for each forward rate produced, according to the raised hypotheses. σ_i ($i = 1, 2, 3.1, 3.2, 4, 5, 6$), ω, ψ_i ($i = 4, 6$) and δ_i ($i = 5, 6$) values were chosen according to the greater similarity with results obtained from real data in the three types of FMEH specification (mean average coefficient and respective average standard errors were considered as calibration guide).

EMPIRICAL RESULTS

The previously described methodology allows this section to be divided into three parts: analyzing long-term exchange market equilibrium mechanisms (indicating which simulation most agreed with the observed data), the same in the short-term and considering a model combining both types of information.

Long-term

Observed data $s_{sem:t}$ and $f_{sem:t,t+1}$ were analyzed to see whether they were stationary, to ascertain whether there were a long-term relationship between spot and forward rates. Unit root tests [Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatowski, Phillips, Schmidt and Shin (KPSS)] were used for determining that the series were I(1), meaning that an equilibrium relationship could have existed between the variables.

The spot rate was then estimated as a constant, as was the forward rate, without restricting the equation coefficients. Some co-integration Durbin-Watson (CRDW), Engle-Granger (EG) and Augmented Engle-Granger (AEG) tests were compared to R^2 [according to Granger and Newbold (1974), if CRDW>R^2, the residual of co-integration regression, is not I(1), then the spurious regression hypothesis is rejected and co-integration is accepted]. The hypothesis that there was a long-term relationship between spot and forward rates was not rejected in all the tests performed. The results agreed with the literature (see Table 2).

Then, six simulated series of the forward rate were produced following the previous procedure, one for each expectation and market equilibrium hypothesis. Table 3 shows the results obtained from the observed data and for those created randomly.

Table 4 presents the hypotheses` bias and MSE for the Co-integration specification. Notice the proximity of results for all the hypotheses concerning the α_1 coefficient and the best performance of models 2, 3 and 4 in the case of α_0. The objective of approaching the co-integration equation's observed coefficients with minimum rank variation was generally achieved (smaller standard errors), as observed in MSE, although the results were not satisfactory by t–statistics.

Analyzing the simulations' MSE behavior in more detail, hypotheses 2 and 3 displayed the greatest coefficient reliability and hypothesis 1 showed the greatest standard error precision. It was observed that the rational and static expectations' hypothesis (hypothesis 3) was nearest to real values when examining the joint performance of the coefficients and their respective standard errors (Figure 1).

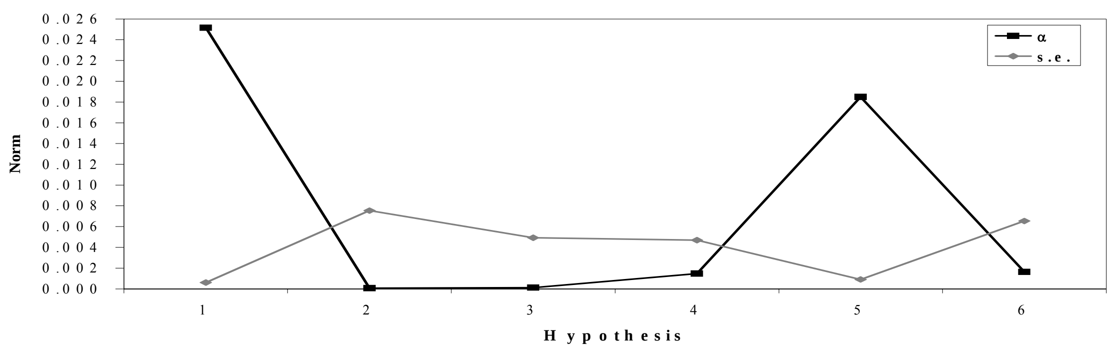
Table 3: Co-integration Equation Results for Real and Fictitious Data

Estimated model: $s_{sem:t+1} = \alpha_0 + \alpha_1 f_{sem:t,t+1} + \nu_{t+1}$

Statistics	Real data	Monte-Carlo simulations					
		H. 1	H. 2	H. 3	H. 4	H. 5	H. 6
α_o	0.0246	0.0496	0.0247	0.0246	0.0247	0.0063	0.0249
s.e.(α_o)	0.0115	0.0109	0.0190	0.0066	0.0161	0.0124	0.0180
T(α_o)	2.1459	4.5610	1.3011	3.7436	1.5325	0.5084	1.3868
α_1	0.9968	0.9937	0.9968	0.9969	0.9983	0.9992	0.9984
s.e.(α_1)	0.0015	0.0014	0.0025	0.0009	0.0021	0.0016	0.0024
T(α_1)	663.0326	696.7563	401.0641	1154.9302	471.3173	616.1130	423.6893
R^2	0.9990	0.9990	0.9971	0.9997	0.9979	0.9988	0.9975
CRDW	1.3506	1.4094	2.0677	1.5967	1.8160	2.0801	1.5543
EG[i]	-14.8596	-15.9739	-22.6383	-17.6632	-19.9303	-21.9848	-17.0501
C.V. EG 1%	-3.9200						
C.V. EG 5%	-3.3500						
AEG_1[ii]	-11.1537	-11.5180	-15.3814	-12.0251	-13.3455	-14.7076	-10.8955
C.V. AEG_1 1%	-3.9200						
C.V. AEG_1 5%	-3.3500						
AEG_2[iii]	-9.8025	-10.1115	-13.2976	-9.6693	-11.7638	-12.4580	-9.2582
C.V. AEG_2 1%	-3.9300						
C.V. AEG_2 5%	-3.3500						
AEG_3[iv]	-8.0319	-8.6511	-11.2189	-8.1632	-9.8173	-9.9051	-7.5544
C.V. AEG_3 1%	-3.9300						
C.V. AEG3 5%	-3.3500						

[I] Engle-Granger Test. H_0: no cointegration (unit root)
[ii] Augmented Engle-Granger Test with a lag. H_0: no cointegration (unit root)
[iii] Augmented Engle-Granger Test with two lags. H_0: no cointegration (unit root)
[iv] Augmented Engle-Granger Test with three lags. H_0: no cointegration (unit root)
CRDW: Durbin Watson of the Co-integration regression, T: t-statistic
C.V.: Critical value s.e.: Standard error of coefficient estimate

Figure 1: Co-integration Equation Coefficients Norm and Their Respective Standard Errors



Source: Authors' calculations

Table 4: Dispersion Measurement of the Co-integration Equation

Statistics	Hypothesis					
	1	2	3	4	5	6
Observed Bias						
α_o	0.0250	0.0000	0.0000	0.0001	-0.0183	0.0003
s.e.(α_o)	-0.0006	0.0075	-0.0049	0.0047	0.0009	0.0065
t(α_o)	2.4150	-0.8448	1.5976	-0.6134	-1.6375	-0.7592
α_1	-0.0031	0.0001	0.0001	0.0015	0.0024	0.0016
s.e.(α_1)	-0.0001	0.0010	-0.0006	0.0006	0.0001	0.0009
t(α_1)	33.7237	-261.9685	491.8976	-191.7153	-46.9196	-239.3433
R^2	0.0001	-0.0019	0.0007	-0.0011	-0.0002	-0.0015
Observed MSE						
α_o	6.24E-04	1.36E-09**	2.78E-10*	8.74E-09	3.36E-04	7.67E-08
s.e.(α_o)	3.60E-07*	5.59E-05	2.39E-05	2.17E-05	8.16E-07**	4.20E-05
t(α_o)	5.83E+00	7.14E-01	2.55E+00	3.76E-01*	2.68E+00	5.76E-01**
α_1	9.44E-06	2.59E-09*	1.42E-08**	2.17E-06	5.83E-06	2.61E-06
s.e.(α_1)	5.96E-09*	9.65E-07	4.10E-07	3.78E-07	1.40E-08**	7.28E-07
t(α_1)	1.14E+03*	6.86E+04	2.42E+05	3.68E+04	2.20E+03*	5.73E+04
R^2	5.38E-09*	3.49E-06	4.72E-07	1.14E-06	2.69E-08**	2.25E-06

* Lowest MSE
** Second lowest MSE

<u>Short-term</u>

Another model used for verifying FMEH comes from estimating spot exchange rate depreciation as a function of forward premium and a constant. The results reported in Table 5 reveal some interesting behavior for Colombia. The estimated β_1 coefficient was generally found to be negative, a different result from that supposed using FMEH (a problem known as forward discount puzzle). After running the regression indicated for Colombia, it was found that the β_0 coefficient was close to zero and the β_1 coefficient was positive, although negative values could not be ruled out if the confidence interval were considered. On the other hand, all the simulations taken together displayed behavior close to that obtained with the observed data, especially regarding the β_1 coefficient.

Table 6 reports individual dispersion measures of the coefficients and Figure 2 show its joint performance. In order to choose a more accurate model (having smaller bias but retaining efficiency), we analyzed the MSE of the hypotheses; finding that the hypothesis standing out from the coefficients was that regarding combined expectations. However, static expectations performed better in standard errors, confirmed when the norms for coefficients and standard errors were compared. The importance of static expectations and risk neutrality in the short-run were reaffirmed regarding the results obtained by Zietz (1995).

Table 5: Results of the Equation in Differences for Real and Fictitious Data

Estimated model: $s_{sem:t+1} - s_{sem:t} = \beta_0 + \beta_1 \left(f_{sem:t,t+1} - s_{sem:t} \right) + \upsilon_{t+1}$

Statistics	Real Data	Monte-Carlo Simulations					
		H. 1	H. 2	H. 3	H. 4	H. 5	H. 6
β_o	0.0014	0.0017	0.0015	0.0013	0.0078	-0.0356	-0.0003
s.e.(β_o)	0.0005	0.0004	0.0004	0.0004	0.0006	0.0042	0.0004
t(β_o)	2.5868	3.9833	3.8890	3.3361	12.9979	-8.4138	-0.6353
β_1	0.1695	0.1687	0.1696	0.1695	0.1696	0.1652	0.1694
s.e.(β_1)	0.2073	0.1449	0.0186	0.0191	0.0132	0.0187	0.0142
t(β_1)	0.8177	1.1643	9.1095	8.8607	12.8134	8.8510	11.9682
R^2	0.0015	0.0029	0.1503	0.1434	0.2593	0.1463	0.2386
DW	1.3303	1.3516	1.4835	1.4487	1.5161	1.2999	1.4873
Q[i]	80.7783	88.6158	68.6054	83.6993	53.2901	120.7793	54.8488
p-value(Q)	0.0000						
LM[ii]	57.3281	58.7576	46.0468	52.4321	38.0831	72.3637	40.3103
p-value(LM)	0.0000						
ARCH[iii]	43.0315	50.7769	40.3821	48.2455	34.4135	36.9019	36.4679
p-value(ARCH)	0.0000						
White[iv]	3.8590	2.8095	7.4444	11.1466	38.7963	14.7788	36.4705
p-value(White)	0.1452						
JB[v]	158.3709	147.7357	145.2882	108.9471	62.9665	79.5286	66.4487
p-value(JB)	0.0000						
Chow[vi]	8.8786	8.9966	10.6997	13.9344	8.1001	22.7503	10.0346
p-value(Chow)	0.0002						

[i] Ljung-Box Q test. H_0: no serial correlation up to order k=4

[ii] Breusch-Godfrey Lagrange multiplier test. H_0: no serial correlation up to order h=4

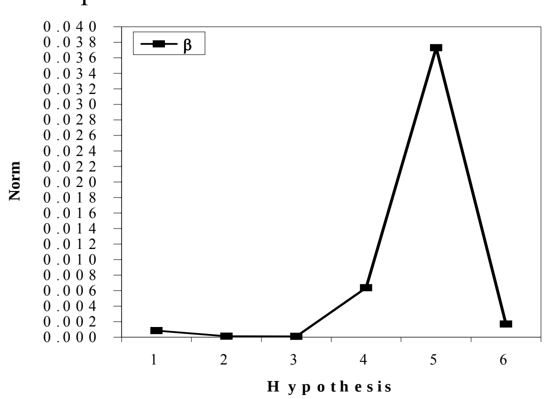
[iii] Autoregressive Conditional Heteroskedasticity (ARCH) Lagrange multiplier test. H_0: no ARCH up to order q=4

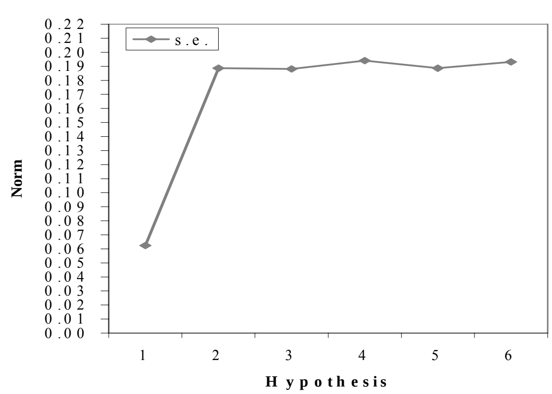
[iv] White test without cross terms. H_0: no heteroskedasticity

[v] Jarque-Bera test. H_0: normally distributed errors

[vi] Chow test, we partitioned the sample in two sub-samples of the same size. H_0: no structural change

Figure 2: Equation Coefficients Norm and their Respective Standard Errors, in Differences





Source: Authors` calculations

Table 6: Dispersion Measurement of the Equation in Differences

Statistics	**Hypothesis**					
	1	**2**	**3**	**4**	**5**	**6**
Observed bias						
β_o	0.0003	0.0001	-0.0001	0.0064	-0.0371	-0.0017
s.e.(β_o)	-0.0001	-0.0002	-0.0001	0.0001	0.0037	-0.0001
T(β_o)	1.3965	1.3021	0.7492	10.4111	-11.0006	-3.2221
β_1	-0.0008	0.0000	0.0000	0.0001	-0.0043	-0.0002
s.e.(β_1)	-0.0624	-0.1887	-0.1882	-0.1941	-0.1887	-0.1932
T(β_1)	0.3466	8.2918	8.0430	11.9957	8.0333	11.1505
R^2	0.0014	0.1489	0.1419	0.2578	0.1449	0.2372
Observed MSE						
β_o	7.85E-08	1.31E-08**	8.27E-09*	4.07E-05	1.37E-03	2.80E-06
s.e.(β_o)	1.46E-08**	2.35E-08	2.25E-08	2.87E-09*	1.36E-05	1.85E-08
T(β_o)	1.95E+00	1.70E+00**	5.61E-01*	1.08E+02	1.21E+02	1.04E+01
β_1	6.27E-07	1.02E-09**	3.82E-10*	3.73E-09	1.88E-05	2.71E-08
s.e.(β_1)	3.89E-03*	3.56E-02	3.54E-02**	3.77E-02	3.56E-02	3.73E-02
T(β_1)	1.20E-01*	6.88E+01	6.47E+01	1.44E+02	6.45E+01**	1.24E+02
R^2	2.02E-06*	2.22E-02	2.02E-02**	6.65E-02	2.10E-02	5.63E-02

* Lowest MSE
** Second lowest MSE

Short-term and Long-term

The error correction model was the last one used in this work. It contained short-term and long-term information in a single equation [an *a priori* supposition regarding the existence of weak forward rate exogeneity regarding spot rate]. The error correction equation was chosen considering some information criteria (Akaike, Schwarz) to avoid problems related to autocorrelation, heteroskedasticity and instability. As in the other specifications, the coefficients results presented in Table 7 were near to the observed data, but were not satisfactory by t–statistics.

According to some dispersion measurements, we summarize our process selection of best performance hypothesis in Table 8 and Figure 3. Hypothesis 1 generally displayed MSE having greater similarity with real data [comparable to Zietz's findings (1995)], followed by hypothesis 3, results being confirmed as shown in Figure 3.

Table 7: Error Correction Equation Results for Real and Fictitious Data

Estimated model: $\Delta s_{sem:t+1} = \lambda_0 + \lambda_1 \left(s_{sem:t} - \hat{\alpha}_0 - \hat{\alpha}_1 f_{sem:t-1,t} \right) + \lambda_2 \Delta f_{sem:t,t+1} + \lambda_3 \Delta f_{sem:t-1,t} + \lambda_4 \Delta s_{sem:t} + \xi_{t+1}$

Statistics	**Real Data**	**Monte-Carlo Simulations**					
		H. 1	**H. 2**	**H. 3**	**H. 4**	**H. 5**	**H. 6**
λ_o	0.0006	0.0008	0.0010	0.0009	0.0011	0.0007	0.0008
s.e.(λ_o)	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
t(λ_o)	1.2561	1.8965	2.5716	2.3671	3.0208	1.8665	2.2440
λ_1	-0.1206	-0.1326	-0.1733	-0.1410	-0.1373	-0.1403	-0.1451
s.e.(λ_1)	0.1821	0.1038	0.0318	0.0430	0.0193	0.0285	0.0233
t(λ_1)	-0.6621	-1.2769	-5.4435	-3.2774	-7.0993	-4.9165	-6.2283
λ_2	0.1846	0.1606	0.1441	0.1626	0.1728	0.1883	0.1801
s.e.(λ_2)	0.2160	0.0714	0.0173	0.0256	0.0147	0.0188	0.0165
t(λ_2)	0.8545	2.2487	8.3144	6.3492	11.7812	10.0407	10.9403
λ_3	0.0722	0.0832	-0.0149	0.0324	-0.0071	0.0319	0.0025
s.e.(λ_3)	0.0495	0.0403	0.0185	0.0254	0.0166	0.0210	0.0186
t(λ_3)	1.4603	2.0667	-0.8075	1.2775	-0.4281	1.5138	0.1363
λ_4	0.2267	0.2617	0.2888	0.2441	0.2048	0.2411	0.2223
s.e.(λ_4)	0.2298	0.0944	0.0453	0.0532	0.0434	0.0456	0.0445
t(λ4)	0.9865	2.7730	6.3785	4.5842	4.7234	5.2868	4.9918
R^2	0.1102	0.1233	0.2229	0.1780	0.3267	0.2779	0.3065
DW	2.0148	2.0191	2.0628	2.0603	2.0382	2.0693	2.0283
Q	5.8760	4.1255	14.8256	15.0536	11.5098	12.8065	12.8624
p-value(Q)	0.2086						
LM	8.8661	5.6332	16.6571	17.9592	12.7571	16.2886	15.1966
p-value(LM)	0.0645						
ARCH	58.6262	65.4645	70.6840	62.3275	30.4613	45.4703	30.3820
p-value(ARCH)	0.0000						
White	104.8199	129.9609	92.6678	79.2201	109.5424	76.7778	104.5011
p-value(White)	0.0000						
JB	175.7742	133.4022	151.8948	114.9149	116.9973	95.5578	111.9197
p-value(JB)	0.0000						
Chow	1.8973	1.7471	2.6037	2.7117	3.3340	1.6474	1.9892
p-value(Chow)	0.0936						

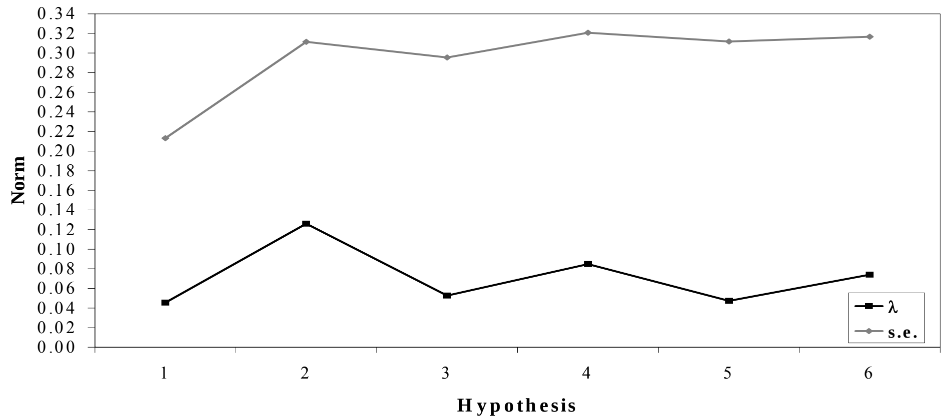
The cointegration coefficients for the real data were the same from Table 3

Table 8: Error Correction Equation Dispersion Measurements

Statistics	Hypothesis					
	1	2	3	4	5	6
Observed Bias						
λ_o	0.0002	0.0004	0.0003	0.0004	0.0001	0.0002
s.e.(λ_o)	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
t(λ_o)	0.6404	1.3155	1.1110	1.7647	0.6104	0.9879
λ_1	-0.0120	-0.0528	-0.0204	-0.0167	-0.0197	-0.0245
s.e.(λ_1)	-0.0783	-0.1502	-0.1391	-0.1628	-0.1536	-0.1588
t(λ_1)	-0.6148	-4.7814	-2.6153	-6.4372	-4.2544	-5.5662
λ_2	-0.0240	-0.0405	-0.0220	-0.0118	0.0037	-0.0045
s.e.(λ_2)	-0.1446	-0.1987	-0.1904	-0.2014	-0.1973	-0.1996
t(λ_2)	1.3942	7.4599	5.4947	10.9267	9.1862	10.0858
λ_3	0.0110	-0.0871	-0.0398	-0.0793	-0.0404	-0.0697
s.e.(λ_3)	-0.0092	-0.0310	-0.0241	-0.0329	-0.0284	-0.0309
t(λ_3)	0.6064	-2.2678	-0.1828	-1.8885	0.0535	-1.3240
λ_4	0.0351	0.0621	0.0174	-0.0219	0.0144	-0.0043
s.e.(λ_4)	-0.1354	-0.1845	-0.1765	-0.1864	-0.1842	-0.1852
t(λ4)	1.7865	5.3920	3.5977	3.7369	4.3003	4.0052
R^2	0.0131	0.1127	0.0678	0.2164	0.1676	0.1963
Observed MSE						
λ_o	3.72E-08**	1.24E-07	9.18E-08	1.98E-07	6.28E-09*	4.26E-08
s.e.(λ_o)	4.81E-09*	1.49E-08	1.20E-08**	2.21E-08	1.52E-08	1.72E-08
t(λ_o)	4.10E-01**	1.73E+00	1.23E+00	3.11E+00	3.73E-01*	9.76E-01
λ_1	1.44E-04*	2.79E-03	4.17E-04	2.80E-04**	3.89E-04	6.00E-04
s.e.(λ_1)	6.12E-03*	2.26E-02	1.93E-02**	2.65E-02	2.36E-02	2.52E-02
t(λ_1)	3.78E-01*	2.29E+01	6.84E+00**	4.14E+01	1.81E+01	3.10E+01
λ_2	5.77E-04	1.64E-03	4.85E-04	1.39E-04	1.38E-05*	2.06E-05**
s.e.(λ_2)	2.09E-02*	3.95E-02	3.63E-02**	4.06E-02	3.89E-02	3.98E-02
t(λ_2)	1.94E+00*	5.56E+01	3.02E+01**	1.19E+02	8.44E+01	1.02E+02
λ_3	1.21E-04*	7.59E-03	1.58E-03**	6.29E-03	1.63E-03	4.86E-03
s.e.(λ_3)	8.43E-05*	9.61E-04	5.79E-04**	1.08E-03	8.08E-04	9.52E-04
t(λ_3)	3.68E-01	5.14E+00	3.34E-02**	3.57E+00	2.86E-03*	1.75E+00
λ_4	1.23E-03	3.86E-03	3.02E-04	4.78E-04	2.08E-04**	1.86E-05*
s.e.(λ_4)	1.83E-02*	3.40E-02	3.12E-02**	3.47E-02	3.39E-02	3.43E-02
t(λ4)	3.19E+00*	2.91E+01	1.29E+01**	1.40E+01	1.85E+01	1.60E+01
R^2	1.71E-04*	1.27E-02	4.59E-03**	4.68E-02	2.81E-02	3.85E-02

* Lowest MSE
** Second lowest MSE

Figure 3: Error Correction Equation Coefficients Norm and their Respective Standard Errors



Source: Authors' calculations

FINAL COMMENTS

After analyzing, using Monte-Carlo simulations, weekly expectations and equilibrium conditions for the Colombian exchange market, evidence indicated that agents tended to be risk-neutral and had equally static and rational expectations. These findings confirm those of Zietz (1995) with monthly data for the US dollar – German mark exchange market and differ from those found with surveys by Jeong & Maddala (1991) and Cavaglia *et al*. (1994).

The results implied that the agents gave preponderance to both the present behavior of the spot exchange rate but also to events, which might affect it in future short-term periods, such as a week. However, as we analyzed just six possibilities, then others should be analyzed, especially those referring to equilibrium, as well using other techniques involving a more detailed analysis of the agents and capturing their differences (i.e. interrelationships).

Bias in prediction caused by risk premiums and transaction costs were not relevant for price formation. This could have been associated with the exchange rate up to September 1999 (exchange bands) and the later reduction of exchange pressure when the brake on inflation was imposed (increasing monetary authority credibility) in the floating exchange regime, thereby providing for a relatively stable exchange rate behavior for the period being analyzed. Regarding transaction costs, the composition of the assets portfolio (in the presence of a diversity of options) allowed costs to become diluted amongst the differing ways to invest in the financial market.

Although this study's objective was not to verify the Market Efficiency Hypothesis, the results obtained suggested that agents do not need a great amount of information to form their weekly expectations about future spot exchange rates and are risk-neutral. This could have resulted from the Colombian exchange market not being very dynamic and the limited number of agents who participate in the market. Future research might examine data with different observation frequencies. Doing so will allow the researchers to identify the role of changes in expectations.

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A COMPARISON OF PORTFOLIO PERFORMANCES OF THE RANDOM AND STRATEGIC STOCK SELECTION STRATEGIES: THE HAMPTON ROADS STOCK PICKING CONTEST

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ABSTRACT

In this paper the performance of the random and the strategic stock selection approaches are compared and tested to determine which results in the greater level of returns to a portfolio of stocks of Virginia based companies. The analysis is conducted via a stock picking contest developed by a local daily newspaper in the Hampton Roads area and hosted by a local university business school. The contest included 1,225 entries, in which contestants chose five stocks from Virginia-based companies. The portfolio return performance of contestants was observed over a 12 week period and the contestant receiving the greatest hypothetical returns over the contest period received a $1,000 US savings bond. The stocks selected by contestants were classified into two aggregated portfolios, indicating whether a random, or a technical/strategic method, was used to pick stock portfolios. A comparison of the two aggregated portfolios indicated that the technical/ strategic selection group out-performed the random walk selection group. In 10 of 12 weeks of the contest the researchers observed a statistically significant difference in the returns of these portfolios. It was also observed that the strategic group out-performed the selected population of Virginia based companies. None of the aggregated average returns from the random or the strategic selection group portfolios out-performed the Standard & Poors 500 Average during the contest.

INTRODUCTION

There are well established theories of how stock prices and stock price changes are determined. Investors who believe markets are perfectly efficient and that investors are rational profit maximizers, would have no need to perform analysis. Most fundamental analysts assume that financial markets are efficient or mostly efficient. They believe that all stocks are correctly priced and opportunities to earn abnormal or excess profits do not exist. For the fundamentalists, stock prices reflect the fundamental economic health of the firm. As such, fundamentalists are likely to analyze the firm's profit, growth, and cash flow prospects in order to determine a fair price for a company's stock. Any information that impacts these fundamental economic elements are likely to impact the firm's stock price as well. Since such changes occur randomly and information about such developments arrives in the market randomly, stock prices are likely to change in a random manner. Hence, price changes follow a random walk according to Fama, (1965).

However, it is also argued that knowing the magnitude or direction of the change in price at period t, will provide information to allow prediction of the magnitude or direction of the change in period t + 1. Technical or trend analysts look beyond the firm's economic indicators for elements that influence stock prices and changes in stock prices. As a group they tend to accept the idea that markets are efficient. However, they believe stock price changes follow certain patterns and that such patterns can be discovered and exploited. They devote much effort to developing charts of market activity usually centered around price and volume behavior. Background information on these theories can be found in the works of Malkiel (1989) and Hilsenrath (2004). It is generally assumed that all investors are rational and are using the same set of available information to assess prices and maximize profits as detailed by Fama (1965). The discussion of the investment environment in which irrational price behaviors is exhibited is described by Thaler & Debondt, (1998).

Both fundamental and technical analysts may see market efficiency as a matter of degree. Either may believe that financial markets are efficient to a degree but not perfectly so. If markets are not perfectly efficient there is an opportunity to discover information that has not been incorporated into security prices. Arguments exist that if an investor acts quickly enough he or she can exploit such inefficiency to earn a so called abnormal return, Thaler & Debont, (1998). These profits are greater than the level justified by the security's risk structure.

Hence, investors who do not believe that markets are perfectly efficient or that they may exhibit irrational behaviors, will be active traders – buying and selling shares to try and stay ahead of the price changes effected by the market's incorporation of new information or exploitable investment behaviors. These active investors believe it is a matter of finding, digesting, and acting upon such information (either new, old, public or private) before the aggregate market can change the share price of a particular stock. Malkiel (1989) argues that if a trading strategy exists, it would allow strategists to exploit the market, but, the cost of transaction fees will reduce the prospect of earning excessive returns.

RESEARCH MOTIVATION AND HYPOTHESIS DEVELOPMENT

In this research, we examine whether the use of a competing stock portfolio selection strategy can result in superior performance as observed by actual average returns in the short-term, for a regional group of Virginia based stocks. In particular, the primary question is whether those subscribing to a random strategy to select a stock portfolio will observe returns different from those using a technical or fundamental strategy. By observing the actual performance of stocks selected using one of these competing strategies the question of the most effective strategy, if one exists, in the short-term, may be answered.

The main question is whether the average returns based on the random stock selection process will be less or greater than the average return on the non-random strategy-based stock portfolio selection method. It is posited based on the existing literature, that in the short term investor's with some specific selection strategy using accounting, financial or industry based data, can not earn higher returns than investors with a completely random selection of stocks.

DATA COLLECTION AND RESEARCH DESIGN

The main source of the data for the study analysis was derived from a local Virginia newspaper's Stock Picking Contest held between January and March of 2005. The newspaper's rules restricted share selection to companies which were headquartered in Virginia or companies possessing a significant presence in Virginia. For example; the Anheuser Busch Company is headquartered in St Louis, but was included, because of the significant plant and employment base in Williamsburg. A complete list of the selection population companies is provided in Table 1. During the contest weekly performance updates were provided by the business faculty of a local university.

Table 1: List of Companies for Selection

Company Name	Company Name	Company Name	Company Name
Advance Auto Parts Inc	Dollar Tree Stores	LCC International Inc.	Shenandoah Telecom Co
AES Corp., The	Dominion Resources	Lowe's Cos. Inc	Shore Financial Corp.
Albemarle Corp.	Dover Corp	Lucent	SLM Corp
Albemarle First Bank	DuPont	ManTech Intl Corp	Smithfield Foods Inc.
Alcoa Inc.	Dynex Capital Inc	Markel Corp.	Southern Fin Bancorp Inc
Alliance Bancshares Corp	Eastern Virginia Bancshares	Massey Energy Co	Spacehab Inc.
Allied Defense Group	ePlus Inc.	Maximus Inc.	SRA International Inc.
Altria Group Inc. (Philip Morris)	Exxon Mobil Corp.	May Dept. Stores	St. George Metals Inc.
American National Bankshares	Fairchild Corp., The	MCG Capital Corp.	Stanley Furniture Co. Inc
American Woodmark Corp.	Fannie Mae	McKesson Corp	Star Scientific Inc.
Amerigroup Corporation	Fauquier Bankshares Inc.	Meadwestvaco Corp	Steelcloud Co
AMF Bowling Worldwide Inc	First Community Bancshares Inc	Media General Inc.	Sunrise Assisted Living Inc.
Anheuser-Busch Companies	First Energy	Microstrategy Inc.	Suntron Corp.
Anteon International Corp.	First National Corp. (VA)	Middleburg Financial Co..	SunTrust Banks
Anthem Inc. (WellPoint)	FNB Corp	Millinieum Bank Corp.	Supervalu Inc
Atlantic Coast Airlines Holdings	Ford	Mills Corp., Inc	Symantec
AvalonBay Communities Inc.	Freddie Mac	National Bankshares Co.	Talk America Holdings
Bank of McKenney (VA)	Friedman, Billings, Ramsey, Gr	NewMarket Corp.	Target Corp.
Bassett Furniture Industries Inc.	Fulton Financial Corp	Nextel Comm Inc	Townebank
BB&T Corp	Gannett Co. Inc.	NII Holdings Inc	Tredegar
BearingPoint Inc.	General Dynamics Corp.	NiSource Inc	Trex Co. Inc
BOE Financial Services of Va.	General Electric	Noland Co.	Tribune
Bowl America Inc.	Genworth Financial Inc	Norfolk Southern	Tyson Foods Inc
Brinks Co.	Gladstone Capital Corp	Northrop Grumman	Union Bankshares Corp
C&F Financial	Greater Atlantic Financial Corp	NVR Inc	Union Pacific
CACI International Inc.	GTSI Corp	Old Point Financial	United Defense Ind Inc,
Cadmus Communications	Halifax Corp.	Online Resources Corp.	United Dom Realty Trust
Capital Automotive REIT	Harbourton Financial Corp.	Optical Cable Corp	United Financial Bank Cos.
Capital One Financial Corp.	HCA Inc	Orbital Sciences Corp.	United Parcel Service
Cardinal Bankshares Corp	Heilig-Meyers Co.	Overnite Corp	Universal Corp./VA
Cardinal Financial Corp.	Henry County Plywood Corp.	Ownes & Minor Inc	US Airwiays Group Inc.
Carmax	Heritage Bankshares Inc.	PEC Solutions	Valley Financial Corp.
Cel-Sci Corp.	HILB Robal & Hamilton	Penney, J.C	Vastera Inc
Central Virginia Bankshares Inc	Home Depot	Performance Food Gr Co.	Vcampus Corp
Chesapeake Corp	Honeywell International Inc.	PHP HealthCare Corp.	Vendingdata Corp.
Chesapeake Financial Shares Inc	Hooker Furniture	Pioneer Bankshares Inc.	Verizon Communications
Cheveron Texaco Corp.	Infineon Technologies	Precision Auto Care Inc	Versar Inc
Church & Dwight Co. Inc	Insmed Inc.	Premier Community Bank	Via Net.Works Inc
Circuit City Stores	InteliData Technologies Corp.	Primus Telecomm	Virginia Commerce Bank
Commonwealth Bankshares	Interstate General Co. LP	ReynoldsAmerican Inc	Virginia Financial Gr Inc.
Commonwealth Biotechnologies	Interstate Hotels & Resorts	RGC Resources Inc	VSE Corp.
Community Bank of N. Virginia	Isomet Corp.	Roanoke Elec Stell Corp.	Wachovia
Community Financial Corp (VA)	James Monroe Bancorp Inc.	Rowe Companies, The	Walgreen Co
Convera Corp.	Kaiser Group Holdings Inc.	S&K Famous Brands	Wal-Mart Stores
Cornerstone Realty Income	Kraft Foods Inc.	Savvis Comm Corp.	webMethods Inc.
CSX	Lafarge North America Inc.	Saxon Capital	Williams Industries, Inc.
Cuisine Solutions Inc.	LandAmerica Fin Group Inc.	Sears & Roebuck Co	Wyeth
Dimon Inc.		Seven-Eleven Inc	

The weekly performance was defined as the average percentage gain (or loss) at the end of a given week compared with the price of the stock portfolios at the beginning of the contest. The contest was advertised in the newspaper on a number of occasions during the month of December, 2004. The advertisement included a mail-in entry form. Contestants were asked to select five companies from the sample list. Each contestant was allowed to enter only once. As a "tie break" strategy, each contestant was also required to estimate the future value of the Dow Jones industrial Average (DJIA) at March 30, 2005. The deadline for selection was Dec 23, 2004. The stock contest had a first place prize award of a $1,000 US saving bond.

The entry form required contestants to briefly describe the procedure used to select their stock portfolio. This information was used as the basis of the research design. Contestants were classified into one of two sample groups by two researchers and a graduate research assistant independently and compared for agreement.

There were 1,391 valid entries in the contest with 1,225 including selection specific information on their mail-in forms. The 346 contestants who indicated that they selected their five companies randomly, with a toss of coin or some other random method were considered in the "random" group. The 879 contestants who indicated a selection strategy based on accounting ratios or a specific industry leadership (fundamental analysis) or based on stock price trends or other economic reason were grouped into a fundamental/technical analysis or "strategy" group. The 166 contestants that did not provide information regarding their stock selection approach are excluded from the study.

The performance of each contestant was tracked each week for 12 weeks starting Jan 3, 2005, and ending March 30, 2005. The weekly results were computed by a local university and published in the newspapers and on the firm's website. Contestant performance rankings were summarized weekly in the newspaper's MONEY AND WORK section. Stock portfolio performance was calculated as the average weekly gain or loss for each stock closing price (or the start price) as of Jan 3, 2005, compared to the closing price at the end of trading, each Wednesday, until the end of the contest on March 30, 2005. To derive the aggregated performance returns of the portfolio, stocks were equally–weighted. The Jan 3, 2005 price was adjusted for any stock splits which occurred during the contest. The contest winner was chosen based on the highest average portfolio return observed between Jan 3, 2005 and March 30, 2005.

FORMULAE

The percentage gain or (loss) for a stock in a given week compared with the initiation date (Jan 3, 2005 closing price) is calculated as;

Percentage Stock Return = $$S_{ij} = \frac{(P_{ij} - P_{i0})}{P_{i0}} \times 100 \qquad (1)$$

Where,

P_{ij} is the closing price of the stock "i" at the end of the j^{th} week,
P_{i0} is the closing price of the stock "i" at the beginning of the contest,
S_{ij} is the percentage return from the beginning on the stock "i" at the end of the j^{th} week.

And the average percentage gain (loss) for each week compared with the initiation date (Jan 3, 2005) is calculated as;

Average Portfolio Return = $$R_{jk} = \sum_{i}^{all\_stocks} \left(\frac{a_{ik} * S_{ij}}{5} \right) \tag{2}$$

Where,

a_{ik} is 1 if k^{th} portfolio contains i^{th} stock (each portfolio has five stocks), 0 otherwise,

R_{jk} is the average percentage return of the k^{th} portfolio in the j^{th} week.

To compare group portfolios we calculated the average performance of each stock portfolio of contestants in the random group and in the strategy group, and then aggregated each portfolio by calculating the group average. The aggregated average portfolio performance of both the random group and the strategic group was calculated for each of the sixteen weeks and a comparison made between the two groups as follows:

Average Group Return = $$G_{jm} = \frac{\sum_{k}^{all\_portfolio} (b_{km} * R_{jk})}{\sum_{k}^{all\_portfolio} (b_{km})} \tag{3}$$

Where,

b_{km} is 1 if k^{th} portfolio belongs to the m^{th} groups (groups are random or strategic) , 0 otherwise,

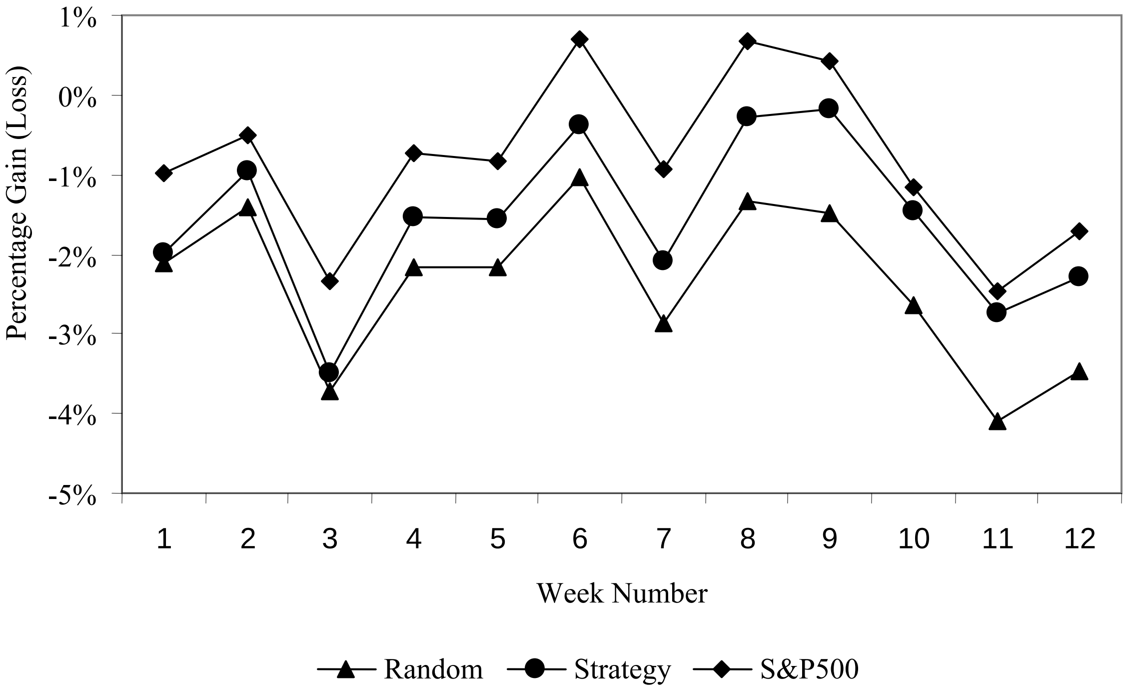
G_{jm} is the average percentage return of the m^{th} group in the j^{th} week.

RESULTS

A summary of the average weekly performance of the random and the strategic groups is presented in Table 2. It is clear that the average performance of the strategic group is higher than the random group during this period. A graphical presentation of these results is presented in Figure 1 below. It is also evident from the data and the graph, that the S&P 500 index performed better than both the strategic and the random groups. The performance of the S&P 500 and the two groups followed similar patterns in the observed gains and losses during the period.. Two separate hypotheses were tested to determine if the S&P 500 performed better than either of the groups. Both hypotheses could not be rejected at an alpha level of 5 percent- a *p-value* of 0.042 and 0.05 for strategic and random groups, respectively. Although not shown, during a majority of the weeks, the strategic group also out-performed all of the stocks of companies of the Virginia based selection population.

To test the significance of the performance difference between the random and the strategic groups, a t-test was conducted, assuming equal variance. The data indicates that the security returns of the strategic group are significantly higher than the random group average returns in 10 out of the 12 weeks of the contest. These results are also presented in Table 2.

Figure 1: Average Weekly Performance of Strategy and Random Portfolios Compared with the S&P 500



Additional Analysis – Control For Bias

Contestants select into a given portfolio, and as a result the size of the strategic group was greater then twice the size of the random group. Although not conclusive, this result implies (from observed behavior) that in the short run the majority of individual investors would use a technical, industry or performance-based methodology in choosing stocks. However, because of the size differential there is the possibility of bias in the statistical results, if the variances of the two groups are not equivalent. Although both samples are statistically large to safeguard against bias, we performed an F-test of the hypothesis that both populations have similar variance.

We found no evidence to reject the hypotheses at a p-value of .58. Hence, statistically both samples have similar variability thus reducing concerns with bias due to size effects. As an additional assurance we tested for the normality of the two samples using a Kolmogorov-Smirnov test. In both cases the data was consistent with a normal distribution. The KS test indicates with a p-value is 0.99, that the strategic group is normally distributed with a mean of -1.605 and standard deviation of 1.233. The random group is also normally distributed with a mean of -2.416 and a standard deviation of 1.188. The p-value of KS test of this group was 0.87. Thus, the sample sizes of the two statistically large groups, even though different, are not significantly so and are not expected to bias results.

Table 2: Test of Significance Two Population *T-test* with an Equal Variance Comparison of the Random Vs Strategic Groups

Week #	Mean Random	Mean Strategy	t Value	P-Value	Significance (error level 5%)
1	-2.120%	-1.988%	-0.992209028	16.06%	No
2	-1.405%	-0.949%	-2.65354733	0.40%	Yes
3	-3.719%	-3.490%	-0.947881002	17.17%	No
4	-2.174%	-1.548%	-2.380140882	0.87%	Yes
5	-2.155%	-1.563%	-2.039134946	2.08%	Yes
6	-1.044%	-0.381%	-2.013693491	2.21%	Yes
7	-2.854%	-2.090%	-2.20498199	1.38%	Yes
8	-1.342%	-0.273%	-2.777538586	0.28%	Yes
9	-1.483%	-0.172%	-3.084463188	0.10%	Yes
10	-2.628%	-1.458%	-2.712236646	0.34%	Yes
11	-4.108%	-2.741%	-2.915585629	0.18%	Yes
12	-3.473%	-2.286%	-2.523403163	0.59%	Yes

Additional Analysis of Results

A number of random group contestants performed relatively well in the overall contest. We test the ratio of these contestants compared with the strategic group in percentile ranks moving from the highest to the lowest ranks of average return performance. Ranks were set at 50 point intervals. Based on the number of contestants in each group the expected ratio of performance is 39.36 percent (or 346 random group contestants divided by 879 strategic group contestants). Table 3 summarizes the end of the contest ratios of the random to strategic group according to membership in the performance rank intervals.

Membership in each of the ranks greater than the expected ratio would indicate a relatively high performance of the random group. For example; in the top 100 performers, there are 15 random selection contestants compared with 68 strategic contestants which results in a ratio of 22 percent compared with an expected ratio of 39.36 percent.

The data indicates that random contestants have a lower percent of membership at the higher "winners" ranks and a higher percentage of membership in the lower "losers" ranks. At the higher rank, there was a less than expected number of random contestants and a continuing rise in the percentage of these contestants in the lower ranks, until the random contestants reach the expected ratio of 39.36 percent at the lower ranks.

To test the statistical significance of the ratios in the top 100 and top 500-ranks, a non-parametric Z-test was performed. The results indicate that the probability of the rejection of all ratios hypotheses is zero.

There are a statistically significant lower number of random selection contestants in the top 100 rank and a significant higher number of random contestants moving towards the bottom 100 rank. This result indicates that the random contestants' performance is deteriorating over the 12 weeks in comparison with the performance of the strategic group. These results are presented in Table 4 below.

Table 3: Ratio of Number of Random to Strategic Selection Participants at the End of the Contest

Ranks	Number of Participants with Random Selection	Number of Participants with Strategic to Select Stocks	Cumulative Number of Participants with Random Selection	Cumulative Number of Participants with Strategic Selection	Ratio of Cumulative Number of With Random Vs Strategy Selection
50	9	34	9	34	26.471%
100	6	34	15	68	22.059%
150	13	32	28	100	28.000%
200	11	34	39	134	29.104%
250	11	32	50	166	30.120%
300	7	41	57	207	27.536%
350	8	37	65	244	26.639%
400	15	25	80	269	29.740%
450	15	29	95	298	31.879%
500	17	28	112	326	34.356%
550	8	35	120	361	33.241%
600	8	34	128	395	32.405%
650	13	35	141	430	32.791%
700	8	32	149	462	32.251%
750	20	25	169	487	34.702%
800	14	30	183	517	35.397%
850	10	35	193	552	34.964%
900	10	30	203	582	34.880%
950	13	32	216	614	35.179%
1000	10	28	226	642	35.202%
1050	21	26	247	668	36.976%
1100	8	33	255	701	36.377%
1150	11	31	266	732	36.339%
1200	18	26	284	758	37.467%
1250	17	28	301	786	38.295%
1300	13	35	314	821	38.246%
1350	17	26	331	847	39.079%
1400	15	32	346	879	39.363%

Table 4: Test of Proportion for the Distribution of Random Selection Participants

Rank	Contestants with Random Stock Selection	Contestants with Strategic Stock Selection	Est. of Prop	Expected Prop	St Err	Z	Probability of Null Hypothesis Acceptance
1st 100	15	68	22.059%	39.363%	1.396%	-12.4259	≈0%
1st 500	112	326	34.356%	39.363%	1.396%	-3.61631	≈0%
Last 500	143	297	48.148%	39.363%	1.396%	6.322979	≈0%
Last 100	32	58	55.172%	39.363%	1.396%	11.35516	≈0%

DISCUSSION

The analysis of the results of the Hampton Roads Stock Picking Contest indicates that in the short-run, stock selection based on some specific strategy outperformed stock selection based on random selection. This difference in the performance can be attributed to the idea that in the short-run, investor behavior may play a greater role in stock price values of companies and the distribution of returns may not reflect rational pricing. Hence, it seems possible that specific strategies can be used to out-perform a random selection stock portfolio at least in the short-run. For example: the Tidewater area of Virginia has a large military presence and a large number of high performing contestants selected companies that were operating in the defense industry. It is possible that contestants' existing or newly acquired knowledge of defense spending or pending contracts to defense companies influenced selection. Such a strategy was proven correct since the largest gainer in the Virginia based selection population of companies was United Defense Industries, Inc. which rose over 55 percent in the three month contest period.

Research Shortcoming

The main drawback to this research is that the contest structure although consistent results in a less than realistic financial environment. For example: Although the possibility of winning a $1,000 saving bond was an adequate incentive resulting in 1,391 contestants, the analysis is based on hypothetical buys into the market without "real" financial gain or loss to contestants, and no impact-up or down- on the security market. The short-term horizon of the contest also limits the strength of results noted and conclusions reached. The limited population of the companies subject to selection also places a constraint on the investment frontier. Moreover, the non-realignment structure of the contest "locked in" some investor positions with firms that may have experienced a loss in stock value over the contest period. For example: At the beginning of the contest, the Fannie Mae Corporation was hit with a major accounting scandal resulting in the resignation a number of its chief executive officers. It would be expected behavior that many contestants/investors would have reduced holdings in such stock and taken positions in other firms. The contest was not structure to allow "losers" to rebalance portfolios to reduce of loss positions. It is because of these reasons that the authors cautious against "sweeping conclusions" based on the results reported.

CONCLUSIONS AND FUTURE RESEARCH ISSUES

In the short-run, a stock selection strategy appears to be superior to a random strategy based on the observed hypothetical portfolio performance. On average, contestants, with a specific stock selection strategy out-performed investors lacking a selection strategy (in the short-term). The number of strategic stock selection investors had a higher population of membership than expected among the top performing portfolios of contestants and a lower than expected membership in the number of poorest stock portfolio performers. In addition, although not shown, in 10 of 12 weeks the contestants who used a strategic portfolio selection criterion had higher average returns than the full population of the Virginia-based company's stock performance. However, the average performance of both the random selection and the strategic groups did not exceed the S&P 500 return average during any of the weeks of the contest.

A concern exists regarding the issue of short-term versus long-term investment performance. It is believed that results noted over a 52 week period, would result in a greater power of tests of significance and provide stronger conclusions regarding differences noted between portfolios. In addition, since the current structure of the contest "locks in" each contestant's selection of stock portfolios, greater realism may be achieved by reducing this constraint to allow each contestant an opportunity to rebalance their portfolios, at some point in the game. Future research would address some of the shortcomings noted above. A subsequent working paper would include items which could be readily changed such as: (1) restructuring the game to conclude after a year, (2) allowing a rebalancing of portfolios each quarter and

(3), matching the size of the portfolios on a "first in" basis. The authors also considered (4) the expansion of the game's stock selection horizon to include the selection of "any" 5 stocks on the NEW YORK or the NASDAQ Stock Exchanges.

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MARKET SECTOR REACTIONS TO 9-11: AN EVENT STUDY

C. Pat Obi, Purdue University Calumet

ABSTRACT

This study presents an overview of how stocks believed to be most vulnerable to the 9-11 attacks reacted, in particular, in the pre-event period. The insider information theory about pre-knowledge of the attacks is carefully analyzed in both the airlines and the financial services sectors of the market. Standard event study methodologies are used to calculate abnormal returns before and after the attacks. Also, risk-adjusted returns are examined to determine whether investors achieved differential performance during the event period. Expectedly, significant negative excess returns occurred in the airlines and financial services sectors due to the incident. A subsequent reversal of excess returns indicates that markets may have overreacted to the attacks. Uncertainties in energy supply resulted in high but short-lived oil prices. Pre-event negative excess returns in airlines and financial stocks are suggestive of a trading pattern that may have been driven by expectation of an impending anomaly.

INTRODUCTION

The 9-11 attacks were a series of coordinated terror attacks in the United States on September 11, 2001. The attacks caused considerable disruptions to the U.S. economy as well as the financial market system. Following the attacks, the broad-based S&P500 index fell by more than 10 percent. The European markets suffered as well. In London, the FTSE 100 lost about six percent while the DAX in Frankfurt closed down 8.5 percent. Both the CAC 40 in Paris and the Swiss Market Index lost more than seven percent of their values. The attacks also revealed the vulnerability of the US financial infrastructure. The stock markets were closed for four days while bond trading was suspended for two. As well, there were significant disruptions in the clearing and settlement systems for government and many other financial assets. Investors seeking safe havens in a time of uncertainty bid up gold and crude oil prices.

It was also apparent that the nature of the attacks caused investors to permanently reassess their market risk perception. Graham and Harvey (2002) explain that the initial reaction of investors was to reduce profit projections by increasing the discount factor for future profits. Drakos (2004) and Straetmans et al (2003) agree, pointing out that total investment risk, in particular in the airline industry, rose substantially after the attacks. Ito and Lee (2005) note that the negative demand shock in the airline industry appeared to persist and could not easily be explained by economic or seasonal conditions.

Anecdotal evidence suggests that trading in the stocks of American Airlines (AMR) and United Airlines (UAL) rose markedly just before the attacks. According to the Bloomberg Financial News, shortly before 9-11, short put option positions in the stocks of Morgan Stanley Dean Witter and Merrill Lynch – both of which were housed in the World Trade Center – were more than 25 times their usual volume.[1] After the attacks, authorities in the US, Europe, and Japan launched an investigation to determine whether any of these trades were on account of the impending attacks. These investigations have so far proved inconclusive.[2]

LITERATURE

Most financial studies on 9-11 focus on market activity after the attacks as well as attempts by the Fed to stabilize the economy. Prior to September 11, 2001, all measures of economic activity suggested that the third quarter of 2001 would produce a negative GDP. Sure enough, when the third quarter numbers came to light, real GDP had contracted -1.4 percent. With consumer confidence at a three-year low, the 2001 recession was well underway.

In a post 9-11 survey of active investors, Glaser and Weber (2003) find that returns forecasts were significantly higher than realized returns as investors believed that markets had overreacted to the attacks. They also discover that volatility forecasts were higher in post 9-11. In a related study, Graham and Harvey (2002) find that investor estimate of the one-year risk premium fell sharply after 9-11. This occurred because volatility forecasts rose as investors grew more wary of the likelihood of more attacks.

Carter and Simkins (2004) present evidence of short-term negative excess returns in the airline industry. Their studies also show that while being concerned about the increased likelihood of financial distress, investors were able to separate airlines that are financially sound from those are financially distressed. In a study of option market activity for AMR and UAL prior to 9-11, Poteshman (2006) finds that while volume ratio statistics were at their typical levels, the long put volume indicator was unusually high. He then concludes that such behavior is consistent with a condition where informed investors trade in advance of a known event.

The efforts by the Fed to mitigate the strain on the payment system are addressed by Cumming (2002), Williamson (2004), and Strauss (2001). This system is the network of financial institutions that ensures the timely settlement of securities transactions. These studies observe that the Fed's efforts to quickly redistribute reserves within the financial system, after the attacks, helped ease the intensity of market disruptions as well as create the impetus for real growth in the GDP.

The risk effect of 9-11 on airline stocks in Europe and the United States is discussed by Drakos (2004) and Straetmans et al (2003). These studies find that both systematic and idiosyncratic risk increased considerably after the attacks. Unfortunately, the latter study makes the nebulous conclusion that the potential for domestic portfolio diversification during crisis periods, when diversification is most needed, decreased compared to pre 9-11 period. Since domestic diversification is typically designed to minimize idiosyncratic risk, it is unclear as to what good such manner of diversification would have done in the face of such a major systematic shock.

In a study of foreign exchange and stock market reactions to terror, Eldor and Melnik (2004) find that market sensitivity to terror does not necessarily diminish with time much though as the market remains efficient. In a similar finding, Chen and Siems (2004) conclude that U.S. capital markets are actually more resilient than ever before. They show that U.S. markets do in fact recover sooner from terror attacks than other major capital markets.

This study is an inquiry about the performance of the designated market sectors before and after 9-11. The market sectors investigated are airlines, financial services, and energy. The evaluation is especially concerned with the level of market efficiency in the pre-event period. Pre-event abnormal price behavior is the basis for verifying possible pre-knowledge of the attacks. Market efficiency in the semi-strong form is evaluated based on post-event abnormal returns. The response of the all-important energy market to the attacks is also addressed. The rest of the paper is organized as follows: data and methodology are described in the next section, followed by a presentation of empirical results. Study conclusions are presented in the last section.

DATA AND METHODOLOGY

The industry groups and futures contracts from which daily price data are obtained for this study are listed in Table 1.

Table 1: Data Sources and Description

Industry	Sample Size of Firms	Geographic Region
Airlines	21	U.S., Europe
Financial services	47	U.S., Europe
Energy	44	U.S., Europe
Crude oil spot	NA	U.S.
Crude oil – 1month futures	NA	U.S.
Crude oil – 4-month futures	NA	U.S.

The airlines and financial services sectors contain all the stocks named by the U.S. regulatory authorities as possible culprits of 9-11 speculative trading. Sample period for the estimation data is November 1996 to May 2001. Altogether, 1142 daily price data are used to estimate the model parameters. Stock price and index data are obtained from CRSP tapes and are adjusted for dividends and stock splits. Crude oil spot and futures data are for the West Texas Intermediate and are obtained from the data base of the Energy Information Administration. Finally, interest rate data are obtained from the Federal Reserve Bank of Saint Louis data bank.

MOTIVATION

The semi-strong form of the efficient markets hypothesis (EMH) implies that all publicly available information is reflected in the market value of a stock. This also suggests that prices respond quickly and accurately to emerging information, making it difficult to achieve abnormal gains in the market. The implication of the EMH is that only information that is not publicly available can benefit investors that seek abnormal gains on their investments. All other information is accounted for in the asset price and, regardless of the amount of fundamental and technical analysis one performs, excess returns cannot be sustained in the long haul (Peterson, 1989 and Fama, 1998).

Occurrence of abnormal returns in the immediate period after the attacks does not necessarily violate the semi-strong form of the EMH. In fact, it is the notion of the EMH that such unanticipated events should bear their full impact on share values. However, when abnormal returns persist long after an event, or when abnormal returns occur prior to the event, it becomes difficult to sustain the EMH. The former condition suggests that investors can earn abnormal returns even after the full effect of the event is known. The latter case suggests that insider information may have created opportunities for abnormal gains in the market. Event studies such as this are generally designed to determine the presence of any or both of such abnormal conditions.

Measuring Excess Returns

Using the risk adjusted returns (RAR) model, abnormal return for each security j is calculated based on the following stochastic process:

$$AR_{j,t} = R_{j,t} - (\hat{\alpha}_j + \hat{\beta}_j R_{M,t}), \qquad (1)$$

where

$AR_{j,t}$	=	Abnormal return for stock j at time t
$R_{j,t}$	=	Actual return for stock j at time t
$R_{M,t}$	=	Return on the market at time t, as proxied by the S&P500 value-weighted index
$\hat{\alpha}_j$	=	Least squares estimate of the intercept of the market model
$\hat{\beta}_j$	=	Least squares estimate of the slope coefficient of the market model

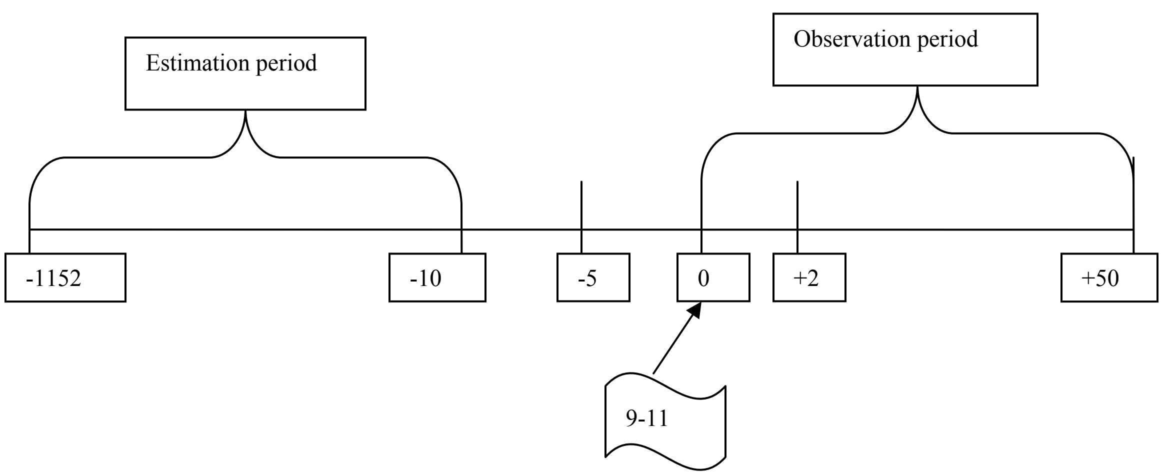
The parameters, α_j and β_j, are estimated from the following market model:

$$R_{j,t} = \alpha_j + \beta_j R_{M,t} + \varepsilon_{j,t}, \tag{2}$$

where ε_t is the residual term, with the following usual properties:

$E(\varepsilon_{j,t}) = 0$ and $Var(\varepsilon_{j,t}) = \sigma^2\varepsilon_{j,}$

Most notably, $\sigma^2\varepsilon_{j,t}$ is the residual variance (mean square error) of the regression.
Model parameters are estimated from the 1142-day period prior to the observation period of the study (day t = -1152 to day t = -10). To avoid confounding events leading up to the observation period, days t = -9 to t = -5 are excluded from the analysis. Pre-event period is the five trading days before 9-11. The event study timeline is as follows:



Measuring Portfolio Performance

One way to determine if the overreaction hypothesis is supported by the excessive price behavior around 9-11 is to discount excess returns by the size of investment risk. [3] The Sharpe Performance Index (SPI) is an appropriate performance measure when total portfolio risk is applied. Excess return is calculated as the difference between the return on the portfolio and the risk free interest rate over the same period. This difference is then discounted by the portfolio's standard deviation. Using sample estimates:

$$\text{SPI} = \frac{\bar{r}_P - \bar{r}_F}{s_P}, \qquad (3)$$

where

$\bar{r}_P$ = Average daily return on the portfolio of stocks during the observation period
$\bar{r}_F$ = Interest rate on risk-free bonds during the observation period, proxied by the yield on 10-year Treasury bonds
$\bar{r}_M$ = Average return on a well diversified market index, proxied by the S&P 500.
s_P = Sample standard deviation of the daily return on the portfolio during the observation period

A SPI value of greater than 1 indicates a superior performance relative to the level of risk taken to earn that excess return. An index value of less than 1 indicates that risk is disproportionate to the excess return earned (Daniel, Hirshliefer, and Subramanyam, 1998).

EMPIRICAL RESULTS

Event study results, showing cumulative average abnormal returns (CAAR) for each of the three equity sectors, are summarized in Table 2. Graphs of average abnormal returns and cumulative average abnormal returns are presented in Figures 1 to 6. A summary of abnormal returns for crude oil futures are presented in Table 3. Table 4 contains results of portfolio performance. The following results are presented with respect to their implications for the efficient markets hypothesis.

Table 2: Market Sector Abnormal Returns Around 9-11

Panel A. Airlines Stocks (n = 21)		
Event Time +	**Cumulative Abnormal Return**	**t Statistic**
t = 1	-0.3726 ***	-24.0417
t = -1	-0.0131	-0.8481
t = -5 to t = -1	-0.0666 *	-1.9222
t = 2 to t = 50	0.2630 **	2.4243
Panel B. Financial Services Stocks (n = 47)		
Event Time +	**Cumulative Abnormal Return**	**t Statistic**
t = 1	-0.0427 ***	-3.8279
t = -1	0.0024	0.2145
t = -5 to t = -1	-0.0376	-1.5081
t = 2 to t = 50	0.0588	0.7535
Panel C. Oil Stocks (n = 44)		
Event Time +	**Cumulative Abnormal Return**	**t Statistic**
t = 1	-0.0202	-1.3670
t = -1	-0.0004	-0.0255
t = -5 to t = -1	0.0104	0.3155
t = 2 to t = 50	-0.0630	-0.6099

***Significant at $\alpha = 0.01$ level ** Significant at $\alpha = 0.05$ level * Significant at $\alpha = 0.10$ level
\+ Day 0 (September 11, 2001): markets yet to open when the attacks occurred at 8:46 AM local time

Event Day Results

The 9-11 attacks occurred prior to the start of trading in the United States. The massive destruction forced the markets to remain closed until September 17, 2001. Consequently, the primary day of market impact was September 17th (day t=1). As expected, for all equity sectors, 9-11 was associated with significant negative abnormal returns on the first trading day after the attacks. The wealth loss in the airlines sector was most severe, with a CAAR return of -37.3 percent; it was -4.3 percent for the financial services sector. These abnormal returns are significant at the 0.01 level. Results are presented in Panels A and B of Table 2 as well as in Figures 1 to 4.

Figure 1: 9-11 Abnormal Returns: Airlines

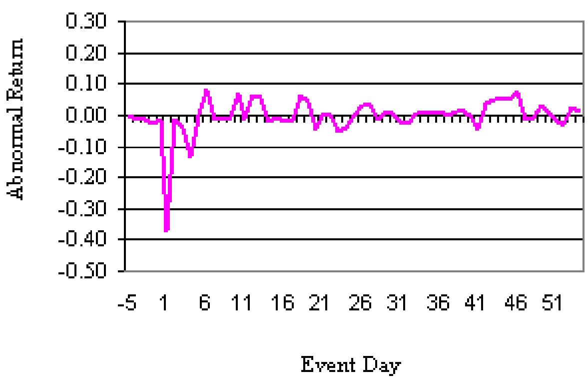


Figure 2: 9-11 Cumulative Average Abnormal Returns: Airlines

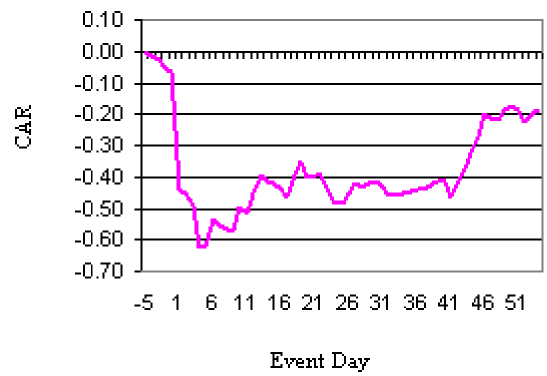


Figure 3: 9-11 Abnormal Returns: Financial Services

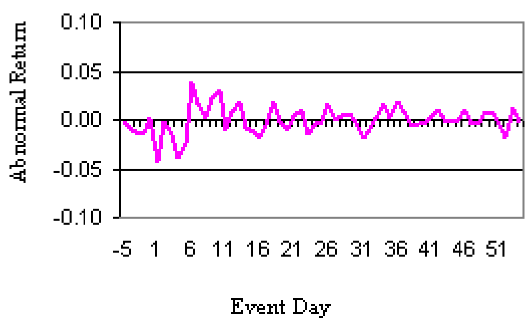
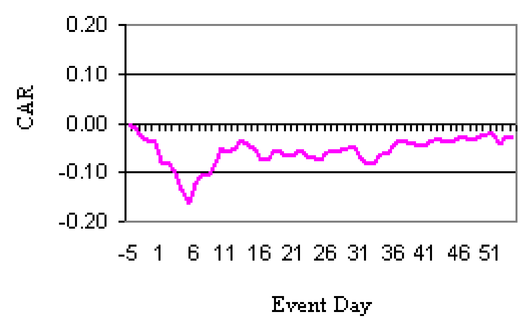


Figure 4: 9-11 Cumultative Average Abnormal Returns: Financial Services



Energy stocks suffered minimal loss on day t=1 as shown in Panel C of Table 2. Cumulative average abnormal return to shareholders was only -2.02 percent, which is not statistically significant. However, the subsequent trend in daily abnormal returns is perhaps more striking. Figure 5 indicates that abnormal returns decreased gradually but persistently to about -5 percent on day t=3. Thereafter, cumulative abnormal returns rose steadily until about day t=18 when the market stabilized. The latter evidence is shown in Figure 6. Why the energy market exhibited this sluggish trend is uncertain. However, it is well documented that crude oil price reacts primarily to unsystematic factors such as market speculation, Middle East conflicts, and production decisions by the Organization of the Petroleum Exporting

Countries (OPEC). When these factors suggest supply disruptions, energy prices tend to rise. The reverse occurs when a supply increase is anticipated (Obi, 1989).

Figure 5: 9-11 Abnormal Returns: Energy

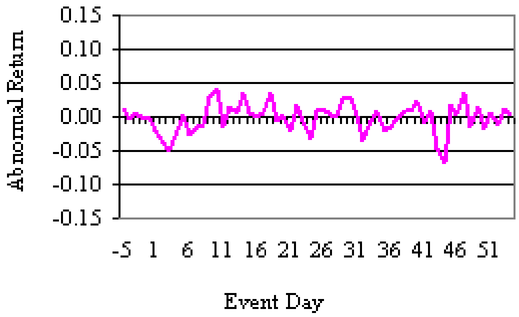


Figure 6: 9-11 Cumulative Average Abnormal Returns: Energy

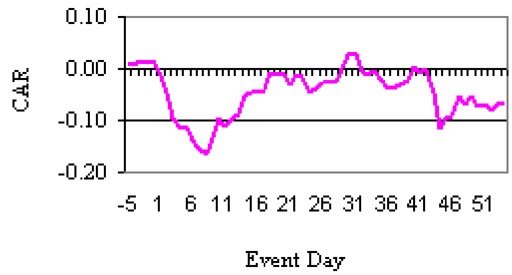


Table 3 presents abnormal returns for crude oil spot as well as 1-month and 4-month crude oil futures contracts. For all maturities, 9-11 was actually associated with positive abnormal returns of about 4.2 percent on day t=1. It is noteworthy that while abnormal returns for all contracts were about the same, only the abnormal return for the 4-month contract is significant at the 0.05 level. This suggests lower price uncertainty for the longer-term contract as speculators apparently factored in long-run market stability in crude oil supply. Event day positive abnormal returns in the oil market also reinforce the notion that oil prices react mostly to factors that are endogenous to the industry in addition to providing investors with safe haven in times of uncertainty.

Table 3: Abnormal Returns of Crude Oil Contracts around 9-11

Event Time	**Abnormal Returns**			**t Statistics**		
	Spot	**1-Month Futures**	**4-Month Futures**	**Spot**	**1-Month Futures**	**4-Month Futures**
t = 1	0.0421	0.0421	0.0420 **	1.6136	1.7053	2.3457
t = -1	-0.0124	-0.0148	-0.0102	-0.4755	-0.6006	-0.5683
t = -5 to t = -1	0.0346	0.0134	0.0171	0.5940	0.2424	0.4279
t = 2 to t = 50	-0.3759 *	-0.3785*	-0.3662 **	-2.0606	-2.1881	-2.9229

*** Significant at α = 0.01 level
** Significant at α = 0.05 level
* Significant at α = 0.01 level

Information Leakage Theory

Evidence of illegal trading with insider information is based on the direction of pre-event abnormal returns. In the absence of any informational leakage, abnormal returns should not be significantly different from zero until the event day. If the market is strong-form efficient and if information related to 9-11 leaked out before hand, there should be a declining trend in cumulative abnormal returns prior to this day. In the circumstance, the substantial decline in abnormal returns on September 17th should only reflect the response of those stocks for which the event was either not anticipated at all or not fully anticipated prior to the event day.

The five-day pre-event CAAR for the three equity sectors are shown on Table 2 (t=-5 to t=-1). Results are mixed. For the airline industry in Panel A, the five-day CAAR is -6.67 percent, which is significantly different from zero at the 0.10 level. Although the pre-event CAAR for the financial services sector is also negative at -3.76 percent, this value is not significant at any conventional level. For the energy equity sector, pre-event CAAR is actually positive but not significant. There is no statistical evidence that pre-event abnormal returns in crude oil futures followed any distinct pattern. Figures 2 and 4 show that the CAAR for both the airline and financial stocks was on a down trend prior to event day. Since fully anticipated events result in maximum abnormal returns prior to event day, it is arguable as to whether 9-11 was in fact partly anticipated prior to the day.

Market Efficiency in the Semi-Strong Form

If the market is semistrong-form efficient, the CAAR should be significant only on the day of the event day or as it were, the first trading day after 9-11. The level of CAAR should not change afterward. If the negative reaction to 9-11 was completed by the first trading day after the attacks, and if the firms in the sample have nothing else in common thereafter, firm-specific abnormal returns should cancel out across the stocks in the portfolio and the CAAR will not change markedly from day to day thereafter.

The last part of the results in Table 2 shows the post-event CAAR for the 50 trading days after 9-11. Post-event CAAR for airline stocks is positive at 26.3 percent. This result is significant at the 0.05 level. Figure 1 shows that the increase in abnormal returns for airline stocks occurred on about the 5th and 41st trading days after 9-11. None of the other equity markets exhibited any significant post-event abnormal trend at least up to about the 36th day, more than a month after the incident. The positive post-event excess return for the airline industry appears to substantiate the finding by Glaser and Weber (2003) that investor returns forecast after 9-11 rose substantially in the apparent belief that financial markets overreacted to the attacks.

Post-event abnormal returns for both the energy equity and commodities markets were negative. However, only cumulative abnormal returns in the commodities market are statistically significant. For example, post-event cumulative abnormal return for 4-month futures was -36.62 percent, which is significantly different from zero at the 0.05 level. This outcome might have been in response to announcements by leading OPEC countries that crude oil supply would be uninterrupted even as the U.S. was set to fight the war on terrorism.

In general, the equity market post-event performance is consistent with an efficient capital market in the semi-strong form. However, the behavior of airline stocks in post-event time appears to run contrary to this notion. This view is reinforced by the overreaction argument alluded to in Glaser and Weber (2003) as well as in Carter and Simkins (2004). Both of these studies suggest that post 9-11 returns forecast by investors was higher than realized returns.

Analysis of Portfolio Performance

Risk-adjusted portfolio performance is analyzed using the Sharpe Performance Index (SPI). Superior performance is achieved if SPI is greater than one. This metric is particularly useful in analyzing the quality of total portfolio performance since excess returns are discounted by total portfolio risk (measured by the standard deviation of returns). Thus, any benefits of portfolio diversification are reflected in the index value; the higher the index value – for indexes greater than one – the more superior the portfolio performance.

Results of the SPI are presented in Table 4 for each of the three equity sectors. None of the SPI values show superior portfolio performance. In fact, for the airlines and financial services portfolios, pre-event

SPI is significantly negative. This suggests gross underperformance compared to what investors could have earned on a riskfree security. While not negative, pre-event SPI for the oil portfolio is less than 1, which also suggests that oil stocks did not outperform the lowest yielding financial asset.

Table 4: Risk-Adjusted Portfolio Performance Around 9-11

Panel A. Airlines Sector			
	Post-event	**Day t=2; t=6**	**pre-event**
SPI	0.3541	-1.2130	-0.8150 ***
std err	0.3514	2.2683	0.2503
P-value	> 0.10	> 0.10	< 0.01
Panel B. Financial Services Sector			
	Post-event	**Day t=2; t=6**	**pre-event**
SPI	0.1326	-0.7269	-0.6268 **
std err	0.1745	1.1799	0.2957
P-value	> 0.10	> 0.10	< 0.05
Panel C. Energy Sector			
	Post-event	**Day t=2; t=6**	**pre-event**
SPI	-0.0336	-1.6991**	0.1779
std err	0.2161	0.5881	0.1931
P-value	> 0.10	< 0.05	> 0.10

*** Significant at $\alpha = 0.01$ level
** Significant at $\alpha = 0.05$ level
* Significant at $\alpha = 0.01$ level

In post-event time, none of the equity portfolios showed superior performance on a risk-adjusted basis. This means that positive gains from market overreactions to 9-11 were, on average, insignificant. This is also true in the immediate five-day vicinity after the attacks, when, perhaps the fear of further attacks was still evident, judging by the negative index values.

CONCLUSIONS

Three sectors of the equity market believed to be most vulnerable to 9-11 are analyzed for their reaction to this event. The sectors are airlines, financial services, and energy. Market speculation in the energy market is observed from the price behavior of crude oil futures contracts. Consistent with the insider information theory, pre-event negative excess returns in the airlines and financial services sectors indicate that the market might have suspected the impending attacks. The same is not true however for the energy sector where abnormal returns over the entire observation period are insignificant. Following the attacks, market prices seemed to adjust upwards which provided investors with positive abnormal returns. Post event gains were more pronounced in the airlines sector where the negative impact of the attacks was most severe.

Initial reaction to the event in the crude oil futures market was actually positive although somewhat muted for the near-term contracts. Positive abnormal returns in crude oil futures are understandable since investors with long positions make money on negative news.

Tests of portfolio performance using the Sharpe Performance Index showed that all three equity portfolios underperformed a riskfree asset in post-event time. Unfortunately, the bounce-back that occurred in the weeks after the incident did little to provide investors with superior performance beyond what they could have earned in low yielding Treasury securities.

In general, except for the idiosyncratic behavior of oil futures, post 9-11 performance revealed the characteristics of a sophisticated market structure. Pre-event and event-day anomalies did not persist in the weeks that followed the incident. Notwithstanding, the notion of market efficiency in the semi-strong form could not be upheld for the airlines sector where post 9-11 fever continued to grip the industry as investors weighed the possibility of further attacks as well as the huge fall off in airline passengers.

FOOTNOTES

1. Mathewson and Michael Nol, "U.S., Germany, Japan Investigate Unusual Trading Before Attack" Bloomberg Financial News, September 18, 2001.

2. Eberhart (2002) reports that the SEC list contained the following airline and financial services stocks: American Express, Bank of America, Bank of New York, Bank One, Citigroup, Continental, Deutsche Bank, General Motors, Lockheed Martin, Lehman Brothers, Lone Star Technologies, John Hancock, Merryl Lynch, MetLife, Morgan Stanley, Northwest, Raytheon, Southwest, USAirways, and W.R. Grace.

3. In general, the hypothesis on market reaction is in three forms: (i) Overreaction hypothesis, which states that extreme one-day price movements will be followed by significant movements in the opposite direction (ii) Under-reaction hypothesis, which argues that extreme one-day movements in stock prices will be followed by additional movements in the same direction, and (iii) Efficient markets hypothesis, which posits that extreme one-day movements in stock prices will not be followed by significant price movements up or down. Original insight is provided in William F. Sharpe, "Mutual Fund Performance," Journal of Business, Vol. 39, No. 1, Part 2, January 1966.

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BIOGRAPHY

Pat Obi is on the faculty of Purdue University Calumet as professor of finance. He received his Ph.D. in Finance from the University of Mississippi in 1989. He teaches MBA-level courses in corporate finance and econometrics. Dr. Obi's research is primarily in energy trading and international finance. He consults extensively for business and industry and is widely published in various academic journals. He is the author of Basics of Business Finance, a text published in the Lithuanian language.

FOREIGN DIRECT INVESTMENT IN LATIN AMERICA: A PANEL REGRESSION STUDY

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ABSTRACT

Since the early 1980s developing countries have generally experienced a heavy influx of foreign capital, and among the developing regions, Latin America has emerged as a prime destination of FDI. An extensive literature has evolved on the inflow of FDI in Latin America, which identifies a number of variables, such as market size, trade openness, etc., as the key determinants of FDI. Due to non-availability of reliable and consistent data, domestic investment climate as a determinant of FDI has been generally excluded from the literature. This study seeks to fill that void by using the Economic Freedom Index, published since 1995 by The Heritage Foundation, as a proxy for domestic investment climate for a sample of 18 Latin American countries over 1995-2004 period. Employing panel regression methodologies, this study finds that economic freedom is a significant and robust determinant of FDI in Latin America. This study also finds that NAFTA has created an insignificant locational advantage for Mexico vis-à-vis other countries in the sample.

INTRODUCTION

Development economists generally concur that the inflow of foreign direct investment (FDI) can play a vital role in the growth dynamics of developing economies. The literature generally accepts that the inflow of FDI in developing countries can help fill at least three "development gaps" – first, the "investment gap" by providing capital for domestic investment; secondly, the "foreign exchange gap" by providing foreign currency through initial investments and subsequent export earnings made possible by the initial investments; and finally, the "tax revenue gap" by generating tax revenues through additional economic activities (Smith, 1997). The FDI inflow can also create many other benefits for recipient economies. For example, FDI can help generate domestic investment in matching funds, increase local market competition, create modern job opportunities, increase global market access for locally produced export commodities, facilitate transfer of managerial skills and technological knowledge from developed countries, etc. -- all of which should ultimately contribute to economic growth in host countries.

Recognizing the manifold benefits of FDI, developing countries have generally eased restrictions on the inflow of foreign capital since the early 1980s. Furthermore, the end of the Cold War in the early 1990s brought about a new political era that not only witnessed the end of the foreign aid programs sponsored by the erstwhile Soviet Union in socialist LDCs (less developing countries), but also diminished strategic alliances between the US and the pro-US developing nations resulting in a sizable reduction in the US-sponsored foreign aid programs. The new political reality forced many LDCs to vigorously seek out alternative sources of foreign private capital. As a result, the annual FDI inflow to developing countries has increased manifold from $23 billion (0.7% of their combined GDP) in 1990 to about $211 billion (2.6% of combined GDP) in 2004 (World Bank, 2006).

The vital role played by FDI in the growth dynamics of developing countries has created considerable research interest among development economists. Consequently, a sizeable empirical literature has evolved on the determinants of FDI. These studies have identified a number of variables, such as market size, economic openness, financial liberalization, rate of return, quality of infrastructure, human capital, political instability, etc. as key determinants of FDI. However, due to non-availability of reliable and consistent set of quantitative data on investment climate, the literature has generally excluded the domestic investment climate in recipient countries as a determinant of FDI. A few recent studies, such as

Quazi (2006) and Quazi and Mahmud (2006), have used the Index of Economic Freedom, an annual publication by The Heritage Foundation/The Wall Street Journal since 1995, as a reliable proxy for domestic investment climate in South Asia and East Asia.

The primary focus of this study is to investigate whether, in addition to the other variables routinely used in the literature, economic freedom is also a significant determinant of FDI in Latin America. Among developing regions, this particular region receives a very high share of FDI, which perhaps can be explained by two factors – first, having formed many trade blocks (such as MERCOSUR, Andean Community, etc.), these countries are at the forefront of free trade movement, which helps attract FDI to the entire region, and secondly, the geographical proximity to the U.S. and Japan – the two most significant source countries of FDI, can also boost their locational advantage. The World Bank (2006) reports that the annual FDI inflow to Latin America & Caribbean countries has jumped from $8 billion (0.8% of regional GDP) in 1990 to about $61 billion (3.0% of regional GDP) in 2004.

This study analyzes the determinants of FDI during 1995-2004 in 18 countries in Latin America - Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. Belize was initially included in the sample, but was ultimately dropped, as data for some key variables were not available for the period covered in the study. One country in the sample that deserves special attention is Mexico, which is currently among the most popular destinations of FDI in the world. This study investigates whether NAFTA has created significant locational advantage for Mexico vis-à-vis other countries in the region. Employing panel estimation methodologies, this study finds that economic freedom is a significant and robust determinant of FDI in Latin America. This study also finds that among the other determinants of FDI, return on investment, trade openness, infrastructure, and incremental lagged changes in FDI help attract more FDI in the region. The results also suggest that, accounting for the economic fundamentals, NAFTA has created an insignificant locational advantage for Mexico vis-à-vis other countries in the sample.

LITERATURE REVIEW

An extensive empirical literature exists on the determinants of FDI in developing countries. Most of these studies have identified market size, quality of infrastructure, labor cost, economic openness, return on capital, political stability, etc. among the key variables that drive the flow of FDI. The literature has by and large excluded the domestic investment climate in recipient countries as a determinant of FDI, as reliable data on investment climate has been generally lacking. There are many instances of conflicting results regarding the direction of influence of the determinants of FDI (Chakrabarti, 2001). Notwithstanding these differences, the FDI literature has continued to grow and capture the fascination of applied development economists.

Scaperlanda and Mauer (1969) put forth the hypothesis that FDI inflow responds positively to the recipient country's market size once it grows beyond a threshold level that is large enough to allow economies of scale and efficient utilization of resources. Many studies have tested this hypothesis for host countries with mixed results. For example, Schneider and Frey (1985), Tsai (1994), and Lipsey (1999) found that higher per capita income, which is used as a proxy for purchasing power and market size, had a positive effect on the FDI inflow, but Edwards (1990) and Jaspersen et al (2000) found the effects to be negative, while Loree and Guisinger (1995) and Wei (2000) found the effects to be statistically insignificant.

Availability of skilled workers can significantly boost the international competitiveness of a host country, which plays a key role in attracting FDI. Several studies, such as Hanson (1996) and Noorbakhsh et al (2001), have used different proxy variables for the level of human capital and found the effects of human capital on FDI to be positive; however, several other studies, such as Root and Ahmed (1979) and Schneider and Frey (1985) found the effects to be statistically insignificant.

Political instability should erode the foreign investors' confidence in the local economy, which in turn should repel foreign investment away. Barro (1991) and Corbo and Schmidt-Hebbel (1991) stated that political instability creates an uncertain economic environment detrimental to long-term planning, which reduces economic growth and investment opportunities. Asiedu (2002) and Haque et al. (1997) contended that countries located in Sub-Saharan Africa are perceived as inherently risky, which likely keeps foreign investors away from that region. Several studies, such as Schneider and Frey (1985) and Edwards (1990), have found that political instability significantly depresses the FDI inflow, but Loree and Guisinger (1995), Jaspersen et al (2000), and Hanson (1996) found the effects to be insignificant. It should be noted here that this present study uses a cross-section of countries from Latin America over 1995-2004 – a period of relative political stability in the region; as a result, political instability is not included in the econometric model as a determinant of FDI.

Other variables routinely used in the FDI literature include: lagged changes in FDI ($\Delta FDI_{i,t-1}$), infrastructure, economic openness, and return on investment. Noorbakhsh et al. (2001) hypothesized that investors, who are typically risk-averse and hesitant to invest in unknown foreign territories, increase their foreign investment incrementally in familiar locations. The study also found that FDI inflow responds positively to lagged changes in FDI ($\Delta FDI_{i,t-1}$), which was used as a proxy for the level of familiarity foreign investors have about a particular country. Edwards (2000), Jaspersen et al. (2000), and Asiedu (2002) found that the rate of return on investment positively affects the FDI inflow, while Edwards (1990) and Gastanaga et al (1998) found that economic openness also causes the same. Finally, several studies, such as Wheeler and Mody (1992), Loree and Guisinger (1995), Asiedu (2002), etc., found that availability (and also quality) of infrastructure, a critical determinant of productivity and international competitiveness, significantly affects the FDI inflow.

THE MODEL

Empirical models found in the FDI literature have generally included various subsets of the following variables as determinants of FDI: trade openness, domestic market size, political instability, human capital, infrastructure, return on investment, incremental lagged changes in FDI (ΔFDI_{t-1}), etc. In the absence of a consistent theoretical framework to guide the empirical work, this study formulates the following general-to-specific model. Since the model is estimated with panel data (time-series data over 1995-2004 from a cross-section of 18 countries), subscript *i* refers to countries and t refers to time.

$$FDI_{i,t} = \alpha + \beta_1 \Delta FDI_{i,t-1} + \beta_2 \text{Economic Freedom}_{i,t} + \beta_3 \text{Trade Openness}_{i,t} + \beta_4 \text{Market Size}_{i,t} \\ + \beta_5 \text{Human Capital}_{i,t} + \beta_6 \text{Infrastructure}_{i,t} + \beta_7 \text{Return on Investment}_{i,t} + \varepsilon$$

Rationale of the Model

Lagged changes in FDI (ΔFDI_{t-1}): Since foreign investors are typically risk averse and tend to avoid unfamiliar territories, it is important for host countries to establish track records of receiving FDI. Furthermore, many MNCs may test new markets by staggering their investments, which gradually reach the desired levels after some time adjustments. Incremental lagged changes in FDI should therefore positively affect the current level of FDI.

Economic Freedom: The overall investment climate in host countries plays a critical role in attracting foreign capital. The investment climate, however, is very difficult to measure or quantify, as it is determined by a host of economic and non-economic qualitative factors. The annual index of economic freedom (EF), jointly published by The Heritage Foundation and The Wall Street Journal, is a reliable proxy for domestic investment climate. The publication defines economic freedom as "the absence of government coercion or constraint on the production, distribution, or consumption of goods and services beyond the extent necessary for citizens to protect and maintain liberty itself" (Heritage Foundation 2006, p. 56). The EF index therefore broadly reflects the extent to which an economy is pursuing policies conducive to free enterprise.

The EF index is constructed by incorporating 50 independent variables that fall under 10 broad categories -- trade policy, fiscal burden of government, government intervention in the economy, monetary policy, capital flows and foreign investment, banking and finance, wages and prices, property rights, regulation, and black market activity. These factors are weighted equally in constructing a country's overall index score on a scale of 1 to 5. A score of 1 signifies a consistent set of policies most conducive to economic freedom, while a score of 5 signifies a set of policies least conducive to economic freedom. Therefore, countries with lower EF index scores are likely to attract more FDI vis-à-vis countries with higher scores.

Market Size: Market demand in recipient countries can play a crucial role in attracting "market seeking" FDI, where the primary objective of multi-national corporations is to serve the domestic market. This type of FDI, however, does not generally flow to poor countries, where consumers do not have adequate purchasing power. The average per capita annual income in the sample countries during the sample period was about US $3,100, which is not particularly high. However, it is possible that some FDI flowing particularly to the middle-income countries in the sample – Argentine (per capita income - $7,450), Uruguay – ($5,900) and Mexico – ($5,600), is "market seeking" in nature. Following the literature, this study uses per capita real GDP as a proxy for the domestic market size.

Human Capital: Multi-national corporations are often attracted to developing nations by the abundance of their cheap labor. The cost advantages yielded by low wages can however be offset by even lower labor productivity in developing nations. Higher level of human capital is a good indicator of the availability of skilled workers, which, along with cheap labor, can significantly boost the locational advantage of a host country. Following the literature, this study uses the adult literacy rate as a proxy for the level of human capital.

Infrastructure: Availability of infrastructure, such as roads, highways, communication networks, electricity, etc. should increase productivity and thereby attract higher levels of FDI. Following the literature, this study uses the natural log of per capita electricity consumption (in kilowatt hours) as a proxy for the availability of infrastructure. In addition to availability, reliability of infrastructure (such as the frequency of electricity outage) could also be a crucial indicator of the overall quality of infrastructure, for which data is not readily available for most countries.

Return on Investment: Higher return on investment should naturally attract higher levels of foreign capital to host countries. Measuring the rate of return on investment, however, is not easy because most developing countries lack well-developed capital markets. To get around this problem, several studies, such as Edwards (1990), Jaspersen et al. (2000), and Asiedu (2002), have used the inverse of per capita income in natural log as a proxy for the return on investment. The rationale is that return on investment should be positively correlated with the marginal product of capital, which should be high in capital-scarce poor countries where per capita income is low (or the inverse of per capita income is high). Therefore, the inverse of per capita income should be positively related to FDI inflow. Following the literature, this study uses the natural log of inverse of per capita real GDP as a proxy for return on investment.

DATA, METHODOLOGY, AND ESTIMATION

This study uses panel data from 18 Latin American countries over 1995-2004. Data for FDI (annual FDI inflow as a percentage of GDP), trade openness (volume of trade as a share of GDP), per capita income, per capita electricity consumption, and adult literacy rate are collected from the *World Development Indicators CD-ROM* (World Bank, 2006), while data for economic freedom are collected from the *Index of Economic Freedom* (Heritage Foundation, 2006). The time frame covered in this study (1995-2004) is determined by the availability of data (the EF index is available from 1995 and the *WDI CD-ROM 2006* reports annual FDI inflow until 2004).

To ensure robustness of the estimated results, two widely used panel regression methods -- Generalized Least Squares (GLS) and Random Effects, are used. The estimated results are presented in Table 1. Among explanatory variables included in the regression equations, incremental lagged changes in FDI, economic freedom, trade openness, infrastructure, and return on investment turned out highly significant with the correct *a priori* signs in both models. Only two explanatory variables – market size and human capital, turned out statistically insignificant. As discussed in the previous section, most countries in the sample are relatively poor (the average per capita income in the region is only US $3,100 with only a handful of countries exceeding $5,000 in per capita income), which perhaps suggests weak domestic markets; it is however also plausible that the proxy variables for market size and human capital – per capita income and adult literacy rates, perhaps inadequately capture their true effects on FDI. The overall diagnostic statistics are satisfactory for both models. The White test for heteroscedasticity was performed for each model, which revealed signs of heteroscedasticity. Therefore, the models were estimated with heteroscedastic panels. Also, it was assumed that the panels have panel-specific autocorrelation parameters (details are available from the author).

Table 1: Determinants of FDI in Latin America (1995-2004)

Explanatory Variables	GLS Model		Random Effects Model	
	Coefficient	**z stat**	**Coefficient**	**z stat**
Intercept	7.43	2.71	11.64	2.21
ΔFDI_{t-1}	0.26	3.15**	0.23	3.22**
Economic Freedom	-0.75	-1.77*	-1.41	-2.29**
Infrastructure	2.22	4.45**	1.79	1.67*
Trade Openness	0.01	2.99**	0.02	1.67*
Return on Investment	2.30	4.31**	2.18	1.96**
Diagnostic Statistics	Sample size = 162		Sample size = 162	
	Log likelihood = -329.09		R^2 Overall = 0.21	
	Wald X^2_5 = 39.93 (P value = 0.00)		Wald X^2_5 = 20.08 (P value = 0.00)	
** Coefficient statistically significant at 5%; * Coefficient statistically significant at 10%				

Table 2 below shows the effects of NAFTA on the FDI inflow in Latin America, which is captured by a dummy variable for Mexico. The estimated results again confirm the results obtained in Table 1, particularly that economic freedom is a significant and robust determinant of FDI. The results also suggest that, vis-à-vis other countries in Latin America, Mexico has not gained a significant locational advantage due to NAFTA. Although this result may at first appear inconsistent with the FDI literature, for example Cuevas et al (2005), Aroca and Maloney (2005), etc., which holds that NAFTA has substantially boosted the FDI inflow to Mexico, a careful analysis reveals that the estimated models here in fact explore whether NAFTA has improved the locational advantage of Mexico over other Latin American countries. Since other Latin American countries already belonged to several trade blocks, such as MERCOSUR (Argentina, Brazil, Paraguay, and Uruguay), Andean Community (Bolivia, Colombia, Ecuador, Peru, and Venezuela), Central American Common Market (Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua), etc., they had been enjoying the fruits of free trade agreements long before Mexico was afforded the same by the creation of NAFTA. Therefore, it appears that NAFTA did not create additional locational benefits for Mexico vis-à-vis other countries in the sample; perhaps NAFTA allowed Mexico to join the club of FDI-friendly destinations.

It is also quite possible that the economic crisis that crippled the Mexican economy in 1995, known as the Tequila Crisis in the literature, perhaps dampened the inflow of FDI in Mexico. Since the aftermaths of NAFTA and the Tequila Crisis coincided in the late 1990s, it is difficult to disentangle their effects on FDI inflow. Nonetheless, this issue presents an avenue of further research, which is however beyond the scope of this study.

Table 2: Effects of NAFTA on the FDI Inflow in Latin America (1995-2004)

Explanatory Variables	GLS Model		Random Effects Model	
	Coefficient	**z stat**	**Coefficient**	**z stat**
Intercept	9.84	3.01	11.78	2.05
ΔFDI_{t-1}	0.26	3.22**	0.23	3.22**
Economic Freedom	-0.95	-2.08**	-1.41	-2.22**
Infrastructure	2.49	4.76**	1.77	1.60
Trade Openness	0.01	2.99**	0.02	1.62*
Return on Investment	2.77	4.50**	2.19	1.84*
NAFTA	0.63	1.57	0.33	0.20
Diagnostic Statistics	Sample size = 162		Sample size = 162	
	Log likelihood = -327.03		R^2 Overall = 0.21	
	Wald X^2_6 = 43.99 (P value = 0.00)		Wald X^2_6 = 19.43 (P value = 0.00)	
** Coefficient statistically significant at 5%; * Coefficient statistically significant at 10%				

POLICY IMPLICATIONS

This study finds that, in addition to the usual determinants of FDI used in the literature, economic freedom, used as a proxy for domestic investment climate, is also a significant and robust determinant of FDI in Latin America. These results suggest that in order to attract more FDI inflow, host countries need to improve their domestic investment climate. Improving domestic investment climate, however, is not an effortless feat. A careful analysis of the economic freedom index (as computed by the Heritage Foundation/Wall Street Journal) suggests that host country governments can improve their domestic investment climate by lowering average tariff rate and non-tariff barriers, reducing tax rates and government expenditures, reducing government ownership of businesses and industries, curbing the inflation rate, lifting restrictions on foreign ownership of resources, liberalizing the banking and financial sectors, allowing market wages and prices, securing private property rights and an independent judicial system, reducing excessive regulatory burden, and reining in black market activities (Heritage Foundation, 2006). Adopting these policies may be politically difficult in the short run, but these policies should yield long-run economic benefits that would far outweigh any short-run political costs.

In line with the literature, this study finds that greater trade openness, better availability of infrastructure, and higher return on investment boost the inflow of FDI in Latin America. Also, higher incremental lagged changes in FDI, which is a proxy variable for foreign investors' incremental knowledge about the host country, is found to significantly increase the current level of FDI in Latin America. This result suggests that if a host country is able to successfully attract incremental FDI, that will boost foreign investors' confidence in an already familiar host country, which in turn will open the door to additional FDI inflow, thus setting a virtuous cycle in motion. Since the level of FDI is not a policy instrument for host governments, they should utilize the available pro-FDI policy instruments to dispel the risk-averse foreign investors' fear of investing in an unknown territory.

CONCLUSIONS

This study investigates the determinants of FDI in Latin America with a panel regression methodology using 1995-2004 data for 18 countries. By explicitly treating domestic investment climate as a determinant of FDI in Latin America, which has been hitherto excluded from the literature due to non-availability of reliable data, this study makes a noteworthy contribution to the relevant literature.

The results estimated in this study suggest that better domestic investment climate, better quality of infrastructure, greater trade openness, higher return on investment, and higher incremental lagged changes in FDI boost the FDI inflow to Latin America, while lack of economic freedom causes the contrary. While these results are generally consistent with the current FDI literature, the result that domestic investment climate is a significant and robust determinant of FDI is a noteworthy improvement over the current literature. This study finds that a domestic investment climate that is not conducive to economic freedom will likely offset the stimulating effects of other positive determinants of FDI. Therefore, strategies should be formulated to promote long-term economic freedom in developing countries, which will likely bring about a healthy economic environment leading to overall economic development.

The research focus of this study is worthwhile as it seeks to further our knowledge of the FDI dynamics in Latin America. A better knowledge of the determinants of FDI is crucial for devising strategies to promote long-term economic development -- a course that holds much at stake not only for Latin America, but also for developing countries in general.

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BIOGRAPHY

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ECONOMIC GROWTH AND FINANCIAL SECTOR DEVELOPMENT

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ABSTRACT

This paper estimates an Odedokun-type "supply-leading" model of financial sector development (FSD) which incorporates both banking and capital market variables as potential drivers of economic growth. The current findings illustrate the impact on economic growth of various measures of FSD which includes basic intermediation services, as measured by M2 and money market mutual funds, and more advanced financial products such as stock market development and risk management services. The empirical findings in this study document an important shift from an exclusive reliance on basic banking services among emerging/developing countries towards an expanding role for the capital markets. An even stronger emphasis on the role of capital markets is documented for a group of advanced countries.

INTRODUCTION

Finding ways to stimulate economic growth is a topic of global concern. Financial sector development (FSD) can play either a leading role in economic growth or it may take a more passive role (derived demand) in response to expanding economics needs. In the very early stages of development causation often runs from economic development to FSD. This view has been labeled "demand-following". On the other hand, as economic growth occurs the direction of causality may reverse and a "supply-leading" relationship develops. Here the efficiency gains associated with the intermediation process help generate continued economic growth. Thus, expanded FSD takes on a "financial sector broadening" dimension where consumers and firms, acting as both investors and borrowers, have more efficient access to basic intermediation service. Expanded access to financial services saves time and lowers transactions costs. Furthermore, the development of large scale financial intermediaries and the linkage of national markets drives information and transaction costs even lower. For example, Gertler (1988) and Levin (1997) show that financial intermediaries can reduce the cost of acquiring firm-specific information, leading to lower transaction costs.

According to Allen and Santomero (2001), at much more advanced stages of growth economic agents may demand increasingly sophisticated types of financial services such as innovative risk management products. By facilitating risk management, improving asset liquidity and lowering trading costs, financial intermediaries can encourage investment in higher-return activities (Obstfeld, 1994; Bencivenga and Smith, 1991; Greenwood and Smith, 1997). This is an example of "financial sector deepening".

LITERATURE REVIEW

Using a model which includes a number of growth-determining variables, Odedokun (1996) analyzes the economic and FSD status of a number of less-developed countries over the 1965 to 1988 period. Odedokun confirms that FSD plays a supply-leading role in promoting economic growth. Furthermore, FSD has a more consistent and statistically significant positive relationship with economic growth than do the other variables in his model. Tsai and Wu (1999) divide financial development into endogenous and exogenous components. Endogenous financial development results directly from economic growth. As an economy grows the aggregate demand for goods and services increases. To expand output, producers must look for efficient ways to raise capital. Consumer, on the other hand, will seek more efficient means to earn higher rates of return on their savings. Consequently, a more efficient financial market is required as the economy grows. In contrast, the exogenous view of FSD suggests that development is either stimulated or retarded by a variety of external factors such as government tax policy, commercial laws, and financial regulation. That is, in order to provide an attractive investment environment, governments often need to reduce tax rates, open financial market to foreign investors, remove barriers in the consumer credit and mortgage loan markets, and establish and enforce laws and regulations to protect creditors and investors. Based on evidence from newly industrialized Asian countries, Tsai and Wu (1999) find that countries which adopt more effective public policies tend to experience more rapid financial development and economic growth than countries which do not. Levine (1998) examines the relationship between the legal system and banking sector development and finds that countries that have well defined creditor rights and effective legal enforcement have better-developed banks than countries where laws do not accord high priority to creditor right and where enforcement is often lax.

The conventional neo-classical one-sector aggregate production function in which financial development constitutes an input to production is still the dominant model. Beck et al. (2000) include financial sector size, level of private credit, and liquidity as proxies for financial sector development. Liquidity is calculated as currency plus demand deposits and interest-bearing liabilities of financial intermediaries divided by GDP. In addition they calculate the ratio of commercial bank to central bank deposits to test the hypothesis that private financial intermediaries are more likely to identify profitable investments, monitor managers more effectively, adopt modern risk management techniques, and mobilize saving more efficiently than government controlled central banks. In addition, they include the ratio of private sector loans issued by depository institutions as a share of GDP.

Levine and Zeros (1998) examine the impact of capital market development using total stock market capitalization and various measures of market liquidity. In addition they calculate the value of recent trading activity and measures of international integration at the global level. As for banking sector development, they use the value of private sector loans made by commercial banks and other deposit-taking banks divided by GDP.

In a recent paper, Liang and Reichert (2006) update and extend the Odedokun using a more recent set of data and a larger sample of both developing and advanced countries. Their paper employs a broad definition of the money supply (M3) as a measure of financial sector liquidity and FSD. The model is estimated over the 1980-2000 period. The pooled regression results consistently indicate a strong "supply-leading" relationship between FSD and aggregate output. At the same time, the results of a set of single equation individual country estimates appear to suggest that the impact of FSD is less pervasive today than in the earlier Odedokun study. Furthermore, as suggested by Granger causality tests, at some point in the economic growth cycle, the driving force turns into a "demand-following" relationship, as increased economic growth leads to higher income and education levels, which in turn generates greater demands for more sophisticated financial and risk management services.

On the other hand, using a single measure of financial sector development, such as M3, may not be sufficient to capture the multi-dimensional financial factors which potentially drive economic growth. In addition, the mix and relative importance of these factors may change over time and during different stages of development. For example, as mentioned above, Levine and Zeros (1998) shows that stock market liquidity and banking development both positively predict economic growth, capital accumulation, and productivity improvement. As mentioned before, well-developed financial markets in turn make it easier for firms to attract financing to meet their investment needs (Rajan and Zingales. 1998).

The current paper addresses both capital broadening and capital deepening issues and includes more disaggregate measures for FSD than earlier works. Financial sector development is now divided into measures of banking sector, stock market, and risk management development. The degree of banking sector development is measured by disaggregating M3 into two major components: a narrower definition of the money supply (M2) and the aggregate level of money market mutual funds. This is done to identify both the transaction and investment demands for liquidity. Stock market development variables include total market capitalization as a measure of the scale of capital market activity and stock market turnover ratio as a measure of market liquidity. Risk management development is proxied by growth in the insurance sector as measured by the total level of life insurance premiums paid during the year. Unit root tests are conducted on all time series variables to insure that the data is stationary. Variables found not to be stationary are measured in first difference form. (For brevity the unit root test results are not included in the paper but the authors will supply the results upon request).

DATA SOURCES AND RESEARCH MEHTODOLOGY

The countries included in this analysis were grouped using the classification system employed in IMF's 2005 World Economic Outlook report. The IMF divides the world into two major groups: 1) emerging market/developing countries and 2) advanced economies. The majority of the data for this study was provided by the 2005 World Bank Economic Indicators along with IMF updates over the 1980 to 2003 period. The data is divided into two sub-periods: 1) 1980-1990, and 2) 1991-2003. This places the economic recessions of 1982 and 1991 at roughly same point in each sub-period. Table 1 - Panel A and B identify the countries in the emerging/developing countries in the early and later periods, respectively; while Panels C and D identify the advanced countries in the later period. After adjusting for missing data the total number of emerging and developing countries included the earlier period is nineteen, which increases to twenty-five countries in the later period. For the advanced countries, eight countries are included in the earlier period and eleven in the later period.

Table 1: Emerging and Developing Countries

Panel A : Earlier Period (1980-1990; N=19)			
Country Code	**Country Name**	**Country Code**	**Country Name**
ARG	Argentina	MAR	Morocco
BRA	Brazil	NGA	Nigeria
CHL	Chile	PAK	Pakistan
COL	Colombia	PER	Peru
CIV	Cote d'Ivoire	PHL	Philippines
EGY	Egypt, Arab Rep.	THA	Thailand
IDN	Indonesia	URY	Uruguay
IRN	Iran, Islamic Rep.	VEN	Venezuela, RB
MYS	Malaysia	ZWE	Zimbabwe
MEX	Mexico		
Panel B: Later Period-Seven Added and One Deleted in Later Period (1991-2003; Total N=25)			
Country Code	**Country Name**	**Country Code**	**Country Name**
CHN	China	LSO	Lesotho
IND	India	LKA	Sri Lanka
MUS	Mauritius	TUN	Tunisia
PAN	Panama	CIV	Cote d'Ivoire (Deleted)

Table 1- Continued - Panel C Advanced Countries: Earlier Period (1980-1990; N=8)			
Country Code	**Country Name**	**Country Code**	**Country Name**
CAN	Canada	USA	United States
JPN	Japan	KOR	Korea, Rep.
AUS	Australia	NZL	New Zealand
DNK	Denmark	CHE	Switzerland
Panel D: Advanced Countries -Three Added in the Later Period (1991-2003; Total N=11)			
Country Code	**Country Name**	**Country Code**	**Country Name**
HKG	Hong Kong, China	ISR	Israel
ISL	Iceland		

As indicated in Table 2, the model includes the annual growth rates for the following factors: 1) labor force (L*), 2) exports of goods and services (X*), 3) capital investment (I), 4) two measures of financial sector liquidity growth (M2*) and money market funds (MFUND*), 5) a proxy for risk management activities (LIFE*), and 6) two measures of capital market activity: a) total stock market capitalization (STKCAP) and b) stock market turnover (STKTUR). GDP (Y) is measured in constant 1995 US dollars. (I/Y) indicates the level of gross fixed capital investment expressed as a percent of GDP, while X* represents growth in the level of goods and services exported in constant 1995 US dollars. L* represents the annual rate of population growth. (Note: an asterisk * is used to denote annual rates of change in the variable).

Table 2: Variable Definitions

Definition	Calculation	Abbreviation
Annual growth rate of real GDP	log(Y)-log(Y(-1))	Y*
Population rate of growth		L*
Growth rate of exports of goods & services	log((X)-log(X(-1))	X*
Gross fixed capital formation (% of GDP)		I/Y
Money and quasi money (M2)[1] ($)		M2
Money market mutual funds ($)	M3-M2	Mfund
The annual growth rate of M2	log(M2)- log(M2(-1))	M2*
The annual growth rate of Mfund	log(mfund)- log(mfund(-1))	Mfund*
Life insurance penetration (% GDP)(first diff)	Life-Life(-1)	Life1
Stock market turnover ratio[2] (first difference)	SKTTUR-SKTTUR(-1)	SKTTUR1
Stock market capitalization/GDP[3] (first diff.)	SKTCAP-SKTCAP(-1)	SKTCAP1

[1] Money and quasi money comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. This definition of money supply is frequently called M2 and corresponds to lines 34 and 35 in the International Monetary Fund's (IMF) International Financial Statistics (IFS). * Denotes rate of growth.
[2] Ratio of value of share traded to total market capitalization
[3] Value of listed shares to GDP

To conserve space, Table 3 provides descriptive statistics for the combined sample period (1980- 2003) for both the emerging/developing countries (Panel A) and the advanced countries (Panel B). In a similar fashion, Table 4 provides the correlation matrix for the emerging/developing countries (Part A) and the advanced countries (Part B) for the total sample period.

Table 3: Descriptive statistics for Emerging and Advanced Countries

Panel A: Emerging Countries									
	Y*	L*	X*	IY	M2*	SKTTUR1	SKTCAP1	LIFE1	MFUND*
Mean	0.04	0.02	0.06	0.23	0.06	0.01	0.01	0.00	0.00
Median	0.04	0.02	0.06	0.22	0.07	0.00	0.01	0.00	0.05
Maximum	0.14	0.04	0.72	0.66	0.51	1.25	1.07	0.04	2.47
Minimum	-0.14	0.00	-1.12	0.09	-0.62	-1.15	-0.71	-0.06	-1.54
Std. Dev.	0.04	0.01	0.12	0.08	0.12	0.20	0.10	0.00	0.40
Observations	426.00	426.00	426.00	426.00	426.00	426.00	426.00	426.00	426.00
Panel B: Advanced Countries									
	Y*	L*	X*	IY	M2*	SKTTUR1	SKTCAP1	LIFE1	MFUND*
Mean	0.03	0.01	0.06	0.24	0.06	0.04	0.04	0.00	0.02
Median	0.03	0.01	0.06	0.23	0.05	0.03	0.02	0.00	0.06
Maximum	0.11	0.04	0.24	0.39	0.46	1.57	0.92	0.03	4.94
Minimum	-0.07	-0.01	-0.12	0.16	-0.08	-1.01	-0.68	-0.01	-4.08
Std. Dev.	0.03	0.01	0.05	0.05	0.05	0.23	0.16	0.00	0.76
Observations	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00	210.00

Table 4: Correlation Matrix for Emerging and Advanced Countries

Panel A: Emerging Countries									
	Y*	L*	X*	IY	M2*	SKTTUR1	SKTCAP1	LIFE1	MFUND*
Y*	1.00	-0.08	0.37	0.27	0.42	0.02	0.20	-0.05	0.15
L*	-0.08	1.00	-0.13	-0.24	-0.06	0.04	0.02	0.02	0.01
X*	0.37	-0.13	1.00	0.12	0.02	0.00	0.09	0.02	0.17
IY	0.27	-0.24	0.12	1.00	0.17	-0.07	0.04	0.06	0.12
M2*	0.42	-0.06	0.02	0.17	1.00	0.05	0.10	0.16	0.13
SKTTUR1	0.02	0.04	0.00	-0.07	0.05	1.00	0.14	-0.01	0.08
SKTCAP1	0.20	0.02	0.09	0.04	0.10	0.14	1.00	0.09	0.00
LIFE1	-0.05	0.02	0.02	0.06	0.16	-0.01	0.09	1.00	0.02
MFUND*	0.15	0.01	0.17	0.12	0.13	0.08	0.00	0.02	1.00
Panel B: Advanced Countries									
	Y*	L*	X*	IY	M2*	SKTTUR1	SKTCAP1	LIFE1	MFUND*
Y*	1.00	0.15	0.47	0.43	0.22	0.10	0.20	0.10	0.13
L*	0.15	1.00	0.06	0.00	0.17	0.02	0.01	-0.01	0.01
X*	0.47	0.06	1.00	0.22	0.08	0.04	0.19	0.05	0.01
IY	0.43	0.00	0.22	1.00	0.20	-0.02	-0.02	0.13	0.07
M2*	0.22	0.17	0.08	0.20	1.00	0.09	0.16	0.01	0.06
SKTTUR1	0.10	0.02	0.04	-0.02	0.09	1.00	0.07	-0.04	-0.13
SKTCAP1	0.20	0.01	0.19	-0.02	0.16	0.07	1.00	0.12	0.08
LIFE1	0.10	-0.01	0.05	0.13	0.01	-0.04	0.12	1.00	0.11
MFUND*	0.13	0.01	0.01	0.07	0.06	-0.13	0.08	0.11	1.00

MODEL

The empirical model is specified in equation 1 as follows:

$$Y^*_t = B_0 + B_1 L_t^* + B_2 X^*_t + B_3 (I/Y)_t + B_4 M2^*_t + B_5 \text{STKTUR1}_t + B_6 \text{STKCAP1}_t + B_7 \text{LIFE}_t + B_8 \text{MFUND}^*_t + u_t \quad (1)$$

where,

Y^*_t = Economic growth is measured as annual growth rate of the real GDP.
L^*_t = Labor force growth was proxied by the annual rate of population growth.
X^*_t = Real export growth was calculated as the annual growth rate of exports of goods and services.
I/Y_t = Indicates the level of gross fixed capital investment expressed as a percent of GDP.
$M2^*_t$ = Annual growth in M2 is our measure of bank intermediation .
$STKTUR1_t$ = Measures stock market turnover or liquidity (first difference).
$STKCAP1_t$ = Measures stock market size or scale (first difference).
$LIFE_t$ = A proxy for risk management activity as measured by the volume of life insurance policies enforce.
$MFUND^*_t$ = Annual growth in money market funds.
u_t = The error term is assume to be a white noise process (normal distribution $(0, \delta^2)$) after adjusting for autoregressive term as necessary

EMPIRICAL RESULTS

To capture time effects, Table 5 presents the regression results for emerging/developing countries for two distinct data periods: Part A: 1980-1990, and Part B: 1991-2003. Table 6 presents the regression results for the advanced countries for the same two data periods: Part A: 1980-1990 and Part B: 1991-2003. (Note: the authors will provide the regression results for the combined data period upon request).

Table 5: Regression Results for Emerging and Developing Countries.

Panel A: Sample Period 1980-1990				
Dependent Variable: GDP Growth (Y)	Cross-sections included: 19	Total (unbalanced) observations: 127		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.01462	0.052247	0.279827	0.7802
Labor (L*)	-2.689291	2.078856	-1.29364	0.1988
Exports (X*)	0.176215	0.036307	4.853496	0
Investment (I/Y)	0.291763	0.103367	2.822584	0.0058
Money Supply (M2*)	0.164993	0.031879	5.17561	0
Stock Market Turnover (SKTTUR1)	-0.005301	0.019515	-0.271642	0.7865
Stock Market Capitalization (SKTCAP1)	0.165548	0.142631	1.160677	0.2486
Life Insurance Premiums (LIFE1)	-3.273405	2.221494	-1.473515	0.1438
Money Market Funds (MFUND*)	0.008777	0.009698	0.905102	0.3676
Autoregressive term AR (1)	0.08642	0.100037	0.863881	0.3897
R-squared	0.592775	Mean dependent var		0.032134
Adjusted R-squared	0.481714	S.D. dependent var		0.052558
S.E. of regression	0.037838	Akaike info criterion		-3.519143
Sum squared resid	0.141738	Schwarz criterion		-2.892078
Log likelihood	251.4656	F-statistic		5.33737
Durbin-Watson	1.912768	Prob(F-statistic)		0

Table 5 Continued - Panel B: Sample Period 1991-2003				
Dependent Variable: GDP Growth (Y)	Cross-sections included: 25	Total (unbalanced) observations: 191		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.039338	0.014432	-2.725718	0.0072
Labor (L*)	1.043045	0.794961	1.312071	0.1914
Exports (X*)	0.073666	0.031088	2.369625	0.019
Investment (I/Y)	0.200264	0.048408	4.137034	0.0001
Money Supply (M2*)	0.11317	0.030506	3.709776	0.0003
Stock Market Turnover (SKTTUR1)	-0.004694	0.011655	-0.402762	0.6877
Stock Market Capitalization (SKTCAP1)	0.13015	0.027554	4.723469	0
Life Insurance Premiums (LIFE1)	-1.382318	0.720967	-1.917313	0.057
Money Market Funds (MFUND*)	0.00269	0.007413	0.362856	0.7172
Autoregressive term: AR (1)	-0.223201	0.080765	-2.763592	0.0064
AR(2)	-0.136676	0.077172	-1.771066	0.0785
AR(3)	-0.203813	0.071913	-2.834178	0.0052
AR(4)	-0.277265	0.071874	-3.857647	0.0002
R-squared	0.497433	Mean dependent var		0.03702
Adjusted R-squared	0.379949	S.D. dependent var		0.040683
S.E. of regression	0.032036	Akaike info criterion		-3.87183
Sum squared residuals	0.158046	Schwarz criterion		-3.241808
Log likelihood	406.7597	F-statistic		4.234073
Durbin-Watson	2.031787	Prob (F-statistic)		0

Table 6: Regression Results for Advanced Countries

Panel A: Sample Period 1980-1990				
Dependent Variable: GDP Growth (Y)				
Cross-sections included: 8				
Total (unbalanced) observations: 76				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.092557	0.031079	-2.978151	0.0042
Labor (L*)	-1.495046	0.91372	-1.636218	0.1071
Exports (X*)	0.139485	0.036766	3.793812	0.0004
Investment (I/Y)	0.508416	0.111266	4.56938	0
Money Supply (M2*)	0.070904	0.038477	1.842764	0.0704
Stock Market Turnover (SKTTUR1)	0.017997	0.012599	1.4285	0.1584
Stock Market Capitalization (SKTCAP1)	0.035852	0.031779	1.12816	0.2638
Life Insurance Premiums (LIFE1)	-0.183738	0.59774	-0.307387	0.7596
Money Market Funds (MFUND*)	0.003357	0.003947	0.850682	0.3984
Autoregressive term AR (1)	0.153638	0.11193	1.372631	0.1751
R-squared	0.738692	Mean dependent var		0.033485
Adjusted R-squared	0.667828	S.D. dependent var		0.028782
S.E. of regression	0.016588	Akaike info criterion		-5.166081
Sum squared residuals	0.016235	Schwarz criterion		-4.644733
Log likelihood	213.3111	F-statistic		10.42417
Durbin-Watson	2.038432	Prob (F-statistic)		0

Table 6 continued Panel B: Sample Period 1991-2003				
Dependent Variable: GDP Growth (Y)				
Cross-sections included: 11				
Total (unbalanced) observations: 92				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.205692	0.027141	-7.578666	0
Labor (L*)	1.071008	0.749462	1.429035	0.1575
Exports (X*)	0.144683	0.034198	4.230767	0.0001
Investment (I/Y)	0.880924	0.107955	8.160116	0
Money Supply (M2*)	0.07662	0.066738	1.148066	0.2549
Stock Market Turnover (SKTTUR1)	0.019048	0.00679	2.805158	0.0065
Stock Market Capitalization (SKTCAP1)	0.04522	0.013395	3.375839	0.0012
Life Insurance Premiums (LIFE1)	-0.30461	0.281287	-1.082912	0.2826
Money Market Funds (MFUND*)	-0.000286	0.001541	-0.185859	0.8531
Autoregressive term: AR (1)	0.54575	0.124887	4.369939	0
AR(2)	0.034797	0.14168	0.245602	0.8067
AR(3)	-0.194167	0.143186	-1.356052	0.1795
AR(4)	-0.137208	0.123141	-1.114238	0.269
R-squared	0.720629	Mean dependent var		0.029866
Adjusted R-squared	0.631554	S.D. dependent var		0.028173
S.E. of regression	0.017101	Akaike info criterion		-5.08703
Sum squared residuals	0.020179	Schwarz criterion		-4.456583
Log likelihood	257.0034	F-statistic		8.090155
Durbin-Watson	1.979802	Prob(F-statistic)		0

Given the large number of coefficients involved in Tables 5 and 6, Table 7 is included to summarize the main regression results. Looking first at the control variable results presented in Table 7, the growth rate of the labor force (L*) is not statistically significant for either group of countries in either period. On the other hand, the growth in exports (X*) has a positive and highly significant coefficient for both groups in both time periods. The export elasticities range from a high of 0.18 in the earlier period to a low of 0.07 in the later period for the group of emerging/ developing countries. The export elasticities for the advanced countries equals 0.14 in both periods. The ratio of gross fixed capital investment (I/Y) expressed as a percent of GDP is positive and statistically significant at the one percent level for both groups and both periods. For the emerging/developing countries, (I/Y) has an elasticity of 0.29 and 0.20 for the early and later periods, respectively. For the advanced countries, the coefficient on (I/Y) is much larger, equaling 0.51 in the earlier period and increasing substantially in the later period to 0.88. Growth in money market mutual funds is not statistically significant for either group of countries in either period

Turning to the main financial sector hypothesis variables, M2 is statistically significant in both periods for the emerging/developing countries, although the coefficient declines by about one-third from the earlier period (0.16 to 0.11). Among the advanced countries M2 is only significant in the early period with an elasticity coefficient (0.07) which is much lower than that reported for the emerging/developing countries. While the coefficient is approximately the same size for the later period it is no longer statistically significant. For the two stock market variables, STKTUR1 and STKCAP1, neither are statistically significant in the 1980-1990 period for both groups of countries. On the other hand, during the 1991-2003 period, the size of the country's stock market as measured by total market capitalization is now highly significant for the emerging/developing countries with a regression coefficient of 0.13, and a t-value of 4.7. During this later period, both stock market variables for the group of advance countries are statistically significant, with the coefficient on STKTUR1 equal to approximately 0.02 and the coefficient on STKCAP1 equal to 0.05. Our measure of risk management, LIFE, is weakly significant for only the later period for the emerging/developing countries and unexpectedly carries a negative coefficient (-1.38). The model's adjusted R^2 for ranges from 38 to 48 percent for the emerging/ developing countries where there is a greater degree of economic diversity. The adjusted R^2 for the advanced countries is substantially greater with a tighter range from 0.63 to 0.67 compared to 0.38 to 0.48 for the emerging/developing countries.

Table 7 - Regression Coefficients Summary

Variable	Emerging	Advanced	Variable	Emerging	Advanced
Labor (L*)			**Stock Market Cap. (SKTCAP1)**		
Early	N.S	N.S	Early	N.S.	N.S.
Late	N.S	N.S	Late	0.13***	0.05***
Exports (X*)			**Life Insurance Premiums (LIFE1)**		
Early	0.18***	0.14***	Early	N.S.	N.S.
Late	0.07**	0.14***	Late	-1.38*	N.S.
Investment (I/Y)			**Money Market Funds (MFUND*)**		
Early	0.29***	0.51***	Early	N.S.	N.S.
Late	0.20***	0.88***	Late	N.S.	N.S.
Money supply (M2*)			**Adj. R^2**		
Early	0.16***	0.07*	Early	0.48	0.67
Late	0.11***	N.S.	Late	0.38	0.63
Stock Market Turn. (SKTTUR1)					
Early	N.S.	N.S.			
Late	N.S.	0.02***			

*10% significant level, **5% significant level, *** 1% significant level, NS not significant

CONCLUSIONS

Financial sector development (FSD) can play either a leading role in economic growth or it may take a more passive role in response to expanding economics needs. In the very early stages of development causation often runs from economic development to FSD. This view has been labeled "demand-following". On the other hand, as economic growth occurs the direction of causality may reverse and a "supply-leading" relationship develops. Here the efficiency gains associated with the intermediation process facilitates economic growth by lowering transactions costs. Furthermore, by facilitating risk management, improving asset liquidity, and reducing trading costs, financial intermediaries can encourage investment in higher-return activities. This paper estimates an Odedokun-type "supply-leading" model which incorporates banking sector, capital market variables, and risk management variables as potential drivers of economic growth.

More specifically, the current findings illustrate the impact on economic growth of various measures of FSD which includes basic intermediation services, as measured by M2 and money market mutual funds, and more advanced FSD services such as stock market development and risk management services. The empirical findings in this study document an important shift from a heavy reliance on basic banking services among both emerging/developing and advanced countries towards an expanded role for the capital markets. This shift is clearly more noticeable among the advanced countries, where our measure of banking sector development ceases to be significant during the 1991-2003 period. On the other hand, among the emerging/developing countries banking sector development continues to play an important role as the shift to capital markets takes place.

Thus, the results suggest that the financial drivers of economic growth have shifted from basic intermediation services supplied by the banking sector in the form of loans and deposits to more efficient and more sophisticated capital market services. It should be noted that the current study does not explicitly consider the role of external factors such as government laws and local business practices along with differences in financial regulation which may either enhance or restrict FSD development and economic growth. In future research we plan to include other countries as data permits and incorporate differences in financial regulation, economic freedom, and creditor rights along with alternative risk management measures.

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A TRADING RULE TEST USING STOCKHOLM AND U.S. CROSS-LISTED SECURITIES

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ABSTRACT

This paper examines the relative efficiency of the U.S. and Stockholm Stock Exchanges. Numerous stocks are cross-listed on United States Exchanges and the Stockholm Stock Exchange. We compare the prices of these firms at near-simultaneous trading times. This study is an extension of an earlier work by Jalbert, Moritz and Stewart (2005), who completed an efficiency test on stocks that are cross-listed on the Stockholm and a U.S. stock exchange, finding evidence of an inefficient market. This paper extends this line of work by conducting a trading rule test to provide additional evidence regarding the efficiency of these markets. The results provided here offer additional evidence of efficiency problems between these two markets.

INTRODUCTION

If pricing differences exist between two markets which trade identical goods, there may be an opportunity to earn an arbitrage profit by selling short in one market and buying to offset the short position in the second market. Previous research has provided evidence that pricing differences sometimes exist between identical securities which are cross-listed on the Stockholm Stock Exchange and a United States Stock Exchange. In this paper, this line of literature is extended by developing and testing trading rules designed to take advantage of these previously identified pricing differences. The evidence here suggests that profitable trading rules can be developed. These findings provide additional evidence to suggest efficiency problems exist between these two markets. The remainder of the paper is organized as follows. Previous literature is examined, followed by a discussion of the data used in the analysis. Next the results are presented and discussed, followed by some concluding comments.

PRIOR RESEARCH

Various studies have considered the relationships between cross-listed shares, with a specific focus on the efficiency of the prices of the two markets. Fisher (1996) first developed the technique of examining serial autocorrelation to test for market efficiency. In this framework, the existence of persistent serial correlation indicates the ability of historical returns to predict future returns. The presence of this type of price predictability is viewed as a violation of weak-form market efficiency. The approach developed by Fisher (1996) has subsequently been used in a plethora of studies, many of which have found significant autocorrelations and cross-autocorrelations. Boudoukh, Richardson, and Whitelaw (1994) provide a summary of some of this work. They attribute these correlations to either 1) market frictions, 2) time-varying economic risk premiums, or 3) market inefficiencies caused by under- and over-reactions to new information. They examine the autocorrelations of futures returns and returns on the underlying spot index of small-firm-weighted portfolios. They conclude that nonsynchronous trading and market frictions are the primary cause of the observed autocorrelations. They argue that frictions caused by nonsynchronous trading have not previously been given enough credit as a source of such autocorrelation.

Jensen (1978) utilized profits from trading rules as an alternative method for testing for market efficiency. This approach compares the returns associated with a specified trading rule to the returns on a buy and hold strategy. The trading rule is based upon historical, publicly available information so that the information would be available to market traders. A few studies which report excess profits from various trading rules are Jegadeesh (1990), Lehmann (1990), Lo and MacKinlay (1990), and Jegadeesh and Titman (1995).

While most efficiency studies have not focused on cross-listed shares, many studies have examined how ADRs are priced. These studies are not entirely in agreement regarding the factors which have the greatest impact on ADR prices. Werner and Kleidon (1996) investigate the extent of intraday integration between U.K. shares and corresponding ADRs traded in New York. Interestingly, they find order-flow between the markets to be segmented. However, they do find some evidence that private information in New York is incorporated into prices in both markets during overlapping trading periods. Sundaram and Logue (1996) examine the pricing and segmentation of markets for cross-listed shares. Cross-listing in the U.S. is found to enhance valuations of cross-listed shares by reducing segmentation between international equity markets.

Jalbert, Moritz and Stewart (2005) examine the pricing of securities that are listed both on the Stockholm exchange and one of the U.S. exchanges. Using near simultaneous data, they identify significant pricing differences for identical stocks on the two exchanges. Specifically, they find statistically significant pricing differences for six of the nine firms examined in the study suggesting an inefficient market. They find that the pricing differences are reduced after 2003. They conduct a Granger Causality test to determine the existence and direction of causality in the series. They find that there is a feedback relationship between the U.S. price and the Stockholm price for eight of the nine series examined. In this paper we extend the work of Jalbert, Moritz and Stewart (2005) by developing a trading rule intended to provide further evidence of statistically different prices and to demonstrate how the previously identified pricing differences might be exploited by an individual trader. The data utilized in the study is discussed next.

DATA

The data used in this study includes stock and exchange rate prices from the period January 1998 through February 5, 2004. The data set is identical to that used by Jalbert, Moritz and Stewart (2005). During this time period, there were seventeen firms that were traded on both a U.S. stock exchange and the Stockholm Stock Exchange. Complete data was available for nine of these stocks so the other securities were eliminated from further analysis. Sweden stock price data comes from the Stockholm exchange website at: (www.stockholmsborsen.se). Corresponding data for U.S. exchange stock prices were obtained from Yahoo! Financial (http://chart.yahoo.com/d). In order to fairly compare prices, the data was adjusted for the effects of differences in share magnitude. For example, one ADR is equivalent to ten shares on the Stockholm exchange for the Ericsson and Swedish Match companies. In addition to stock prices, data on the exchange rate between the U.S. dollar and Swedish Krona was collected from the Pacific Exchange Rate Service (http://fx.sauder.ubc.ca/data.html).

To facilitate the analysis, the stock price data as well as the exchange rate data were synchronized in time. A two-step process was utilized to synchronize the data. The first step was to match the trading dates of the data. This step adjusted for differing holiday schedules between the two countries. In instances where either exchange was closed, all data for that day was eliminated from consideration. In addition, there were several dates where data were not available due to a lack of trading. In these instances, involving nine observations over the seven year period, the data was eliminated from consideration. The second step in the synchronization process was to synchronize the data by time-of-day. A six-hour time difference exists between New York and Stockholm. As such, collecting closing data from the two exchanges would result in non-synchronized data problems. Further complicating the data synchronization issue is the fact that the Stockholm and U.S. exchanges do not share common trading hours. The Stockholm stock exchange is open from 7:30 a.m to 5:30 p.m. local time each day while the

NYSE operates from 9:30 a.m. to 4:00 p.m. local time each day. Since there is an eight and one half hour difference between the close of trading on the two markets, we are not able to compare daily closing prices directly across the exchanges. In order to most closely match the data, U.S. opening price data (9:30 AM local time), is synchronized with closing data from the Stockholm Exchange. This matching procedure minimized the time differences between trading on the two exchanges. Specifically, by using this matching technique, the time difference between the data collection points is a maximum of two hours. In instances where the closing price collected on the Stockholm exchange was for a trade completed prior to the close, or instances where the opening price obtained from the NYSE was for a trade that occurred after the exchange opened, the time difference in the data collected on the two exchanges is less than two hours.

Clearly, intraday data could improve the accuracy of the synchronization and the precision of the test results reported here. However, such data was not available to the authors. Certainly, the extent to which the data is not synchronized limits the study. However this study is not the first to utilize data that is not perfectly synchronized. Other notable efficiency studies have been conducted using non-synchronous data including Rendleman and Carabini (1979). Second, the timing difference will not bias the results of this study as long as systematic intraday trends in stock price do not persist. It is expected that any pricing differences related to timing errors would be random and serve to offset each other. That is, price differences induced by timing differences are equally likely to be higher or lower, in a random fashion, on one exchange or the other and at any time frame. To the extent that the market is in a sustained period of price increases or decreases, timing differences could bias the results presented here. However, the time period examined in this study involves both times of increasing stock prices and decreasing stock prices, thus, any time induced bias would offset over time.

SUMMARY STATISTICS AND EARLIER FINDINGS

The analysis begins by presenting basic statistics and the relevant test results in Tables 1 and 2. These results are as reported in Jalbert, Moritz and Stewart (2005) and are reproduced here because they represent a description of the data common to both studies and the prime results that are to be expanded upon in the current paper. Table 1 provides general information about the nine firms that are included in the sample. Column 1 and 2 contain the firm name and ticker symbol. Columns 3 and 4 contain the beginning and ending dates of data availability. The number of data points available for each firm are reported in column 5. Column 6 and 7 contain the average daily trading volume on each exchange. Finally, column 8 indicates which U.S. exchange the firm is traded on. Average daily trading volume are reported for each firm as reported on June 1, 2004 at Yahoo.com for the U.S. exchanges, and as reported by the Stockholm exchange.

In Table 2, the extent and number of pricing differences between the two exchanges are reported. The column labeled > 0 indicates those instances where the price is higher in Stockholm that in the U.S. The column labeled < 0 indicates those instances where the price is higher in the U.S. than in Stockholm. For Autoliv, there were 903 observations where the price was higher in Stockholm than in the U.S. There were 544 observations where the price was higher in the U.S. than in Stockholm. We continue by examining the magnitude of the pricing errors. Columns 5 and 6 indicate those observations where the pricing difference exceeded $0.50 per share. There were 322 observations where the price in Stockholm was more than $0.50 per share higher than in the U.S. for the Autoliv company. There were 34 observations where the price was more than $0.50 per share higher in the U.S. than in Stockholm. Next we examine situations where the price difference is more than $1.00 per share. In 72 observations the price in Stockholm was more than $1.00 per share higher than the U.S. price. Four observations occurred where the price was more than $1.00 per share higher in the U.S. than in Stockholm. The differences in prices are found to be significant for six of the nine firms in the sample. Interestingly, three of the six differences are significantly positive, indicating that the average price in Sweden was significantly greater than that witnessed in the U.S., while the other three differences were negative, indicating higher average prices in the U.S. than in Sweden.

Table 1: Sample Firms Summary Data

Company	Ticker	Data Start	Data End	Obs.	Avg. Daily Trade Volume in U.S.	Avg. Daily Trade Volume in Stockholm	U.S. Exchange
Astrazeneca	AZN	4-6-1999	2-6-2004	1,149	1,097,183	692,930	NYSE
Autoliv	ALV	1-2-1998	2-6-2004	1,447	372,772	597,055	NYSE
Biacore	BCOR	1-31-2000	2-6-2004	949	1,181	18,273	NASDAQ
Electrolux	ELUX	1-2-1998	2-6-2004	1,437	14,545	2,177,050	NASDAQ
Ericsson	ERICY	1-2-1998	2-6-2004	1,446	3,634,863	212,281,065	NASDAQ
Maxim	MAXM	1-2-1998	2-6-2004	1,446	492,123	276,221	NASDAQ
Oxigene	OXGN	1-2-1998	2-6-2004	1,440	260,136	62,693	NASDAQ
Tele2	TLTOA	1-2-2000	2-6-2004	967	49	709,232	NASDAQ
SW Match	SWMAY	1-2-2000	2-6-2004	963	1,000	2,134,424	NASDAQ

Table 2: Pricing Error Summary

Company	Obs.	>0	<0	>0.5	<-0.5	>1	<-1
Astrazeneca	1,149	557	592	166	210	26	53
Autoliv	1,447	903	544	322	34	72	4
Biacore	949	519	444	267	235	105	87
Electrolux	1,437	730	717	178	189	37	46
Ericsson	1,446	743	703	106	93	25	33
Maxim	1,446	519	444	267	235	105	87
Oxigene	1,440	732	708	50	58	11	11
Tele 2	967	544	423	251	201	114	96
SW Match	963	519	444	267	235	105	87

Jalbert Moritz and Stewart (2005) also examine the pricing errors before and after 2002. They find many fewer pricing errors after 2002 than before 2002. This finding suggests that the market may not have been efficient at one point but is moving toward increasing efficiency. A Granger Causality test is conducted to determine the extent of causality between the two series. A feedback relationship is found where prices in the U.S. Granger cause prices in Stockholm and prices in Stockholm Granger Cause prices in the U.S. Next, a trading rule is developed to determine if these differences can be exploited by traders.

TRADING RULES WITHOUT TRANSACTION COSTS

In this section we expand upon the work of Jalbert, Moritz and Stewart (2005) by applying a trading rule test that is designed to capitalize on the information discovered in that study. Specifically, we investigate the effectiveness of an arbitrage trading rule which compares the daily closing price in Stockholm with the coinciding opening price in New York. In this section we develop a trading rule test that ignores the effects of transaction costs. A test that considers transaction costs is presented in the next section.

The trading rule is developed as follows. The stock price on the U.S. exchange and the Stockholm exchange are examined each day. If the difference between these prices is greater than a pre-specified filter level, a trade is made in each market. The size of the trade is fixed and specified prior to implementing the strategy. When a trade is indicated, the strategy purchases shares of the lower-priced security and short-sells shares of the higher-priced security. There is not a preset holding period for the shares. If the difference is positive, a long position is initiated in NYC and a short position is initiated in Stockholm. If the difference remains positive on subsequent trading days, additional shares are added to the long NYC position as well as the short Stockholm position. When the difference reverses, the process of unwinding the position is initiated. The profit or loss on the position is tracked daily. Table 3 illustrates the mechanics of the rule as applied to Astrazeneca.

Table 3: Trading Rule Example

Date	AZN Stockholm	AZN NYC	Diff	Action	Shares Stockholm	Shares NYC	Profit
4/7/99	$46.64	$45.19	$1.45	Sell STK; Buy NYC	(21.44)	22.13	$0.00
4/8/99	$45.53	$44.39	$1.14	Sell STK; Buy NYC	(43.40)	44.66	$6.10
4/9/99	$45.20	$43.53	$1.67	Sell STK; Buy NYC	(65.53)	67.63	($17.98)
4/12/99	$44.38	$43.78	$0.60	Sell STK; Buy NYC	(88.06)	90.47	$52.66
|	|	|	|	|	|	|	|
5/11/99	$38.34	$38.12	$0.22	No Trade	(429.55)	441.16	$348.01
5/12/99	$38.78	$38.61	$0.17	No Trade	(429.55)	441.16	$375.18
5/14/99	$39.01	$40.09	($1.08)	Buy STK; Sell NYC	(403.92)	416.22	$929.30

The example shows that on April 7, 1999, the difference between the Astrazeneca stock price in Stockholm and New York was $46.64 - $45.19 = $1.45. This positive difference is greater than the filter amount, indicating that $1,000 worth of Astrazeneca shares should be purchased in New York and simultaneously sold in Stockholm. This results in a short position of 21.44 shares in Stockholm and a long position of 22.13 shares in New York. Since the investment in each market is $1,000, the net profit from the positions is $0. On the following day, April 8, 1999, the stock price dropped in both markets. However, the difference between the stock prices was still positive and greater than the filter level at $45.53 - $44.39 = $1.14. This indicates that another $1,000 of shares should be short sold in Stockholm and simultaneously purchased in New York. These transactions roughly doubled the initial positions and subtracting the market value of the short position from that of the long position results in a $6.10 arbitrage profit. On April 9, notice that the positive difference persisted and the same action was taken. Again, the stock price declined in both markets, but the fact that the New York price declined more than the Stockholm price results in a $17.98 loss on the strategy at that point. On April 12, 1999, the price in Stockholm declined while the New York price increased. The price difference of $0.60 was still slightly greater than the filter level, so the process was repeated and the cumulative profit for the strategy was $52.66 as of that day. If at some point, the difference becomes negative and exceeds the size of the filter, as it did for Astrazeneca on May 14, 1999, then the rule indicates the purchase of $1,000 worth of shares in Stockholm and the sale of $1,000 worth of shares in New York.

The final three rows of Table 3 jump forward to May 11, 12, and 14 of 1999. On May 11 and 12, the difference between the stock prices in Stockholm and New York City was $0.22 and $0.17 respectively. In each case, the difference was less than the filter level of $0.50, so no action was taken and the number of shares remained constant. On May 14, the price in New York exceeded the price in Stockholm such that the price difference was -$1.08. This negative difference exceeded the filter amount and indicated that $1,000 worth of shares should be purchased in Stockholm and a corresponding value should be sold in New York. In this case the number of shares short in Stockholm declined and the number of shares owned in New York also declined, resulting in a cumulative profit of $929.30 for the strategy to that point.

Table 4 reports the arbitrage profit from implementing this strategy using various filter levels. Each panel contains summary results for trading rules based upon price differences between identical securities traded on exchanges in both Stockholm and New York. The rows of each panel report the total arbitrage profit from the strategy, the maximum, minimum, and the standard deviation of profit for the strategy during this sample period. Also provided are the number of trading days where the strategy profit was negative and the total number of observations for that particular security. The size of the filter is listed at the top left-hand side of each panel. For example, the first panel reports the result from trades which were initiated when the price difference between exchanges was + or - $0.50. When the difference between the stock prices exceeds the filter level a trade is initiated. The columns provide summary data for each cross-listed company included in the sample. The arbitrage profit row represents the accumulated profit from implementing this rule. The maximum profit, minimum profit and standard deviation during the sample period are also reported. The observation < 0 row reports the number of days in the sample where the arbitrage profit for the strategy was negative. Total observations for each security are provided on the final row of each panel.

Table 4 represents the results from trading $1,000 worth of securities in each market when the difference between prices exceeds the specified filter. In Panel A, a $0.50 filter is used, in Panel B, a $1.00 filter is used, in Panel C, a $2.00 filter is used and in Panel D, a $3.00 filter is used. Various investment amounts were considered, however they did not have any impact on the results. The only effect of trade size is to increase or decrease the magnitude of the profit.

The filter strategy was profitable for each security in each panel regardless of the size of the filter used. In general we see the larger the filter size, the larger the average arbitrage profit across the nine securities. The same pattern is seen in the average maximum profit, average minimum profit, standard deviation of profit, and average number of observations where a negative cumulative profit was observed. These findings indicate that while smaller filters result in a larger total profit during this sample period, they are also more risky. In summary, the results indicate that an investor who could trade in the Stockholm and New York City markets at the observed prices, could successfully earn an arbitrage profit over time.

Another compelling facet of the success of these trading rules relates to results presented in a previous section of this paper. Earlier, we noted significant differences between the prices in the U.S. and Sweden for six of the nine stocks considered here. Interestingly, three of the six differences are significantly positive, indicating that the average price in Sweden was significantly greater than that witnessed in the U.S., while the other three differences were negative, indicating higher average prices in the U.S. than in Sweden. The trading rule produced a profit for all nine securities included in our sample. That is to say that it did not matter if the average daily prices for a particular security were significantly larger or smaller in one market. The rule was profitable even when investing in securities where the average daily price was not significantly different between the two markets.

Table 4: Trading Rule Results

Each panel contains summary results for trading rules based upon price differences between identical securities traded on exchanges in both Stockholm and New York. The size of the filter and are listed at the top left-hand side of each panel. For example, the first panel reports the result from trades which were initiated when the price difference between exchanges was + or - $0.50. The dollar amount per trade was $1,000 in each case. The columns provide summary data for each cross-listed company included in the sample. The arbitrage profit row represents the accumulated profit from implementing this rule. The maximum profit, minimum profit and standard deviation during the sample period are also reported. The observation < 0 row reports the number of days in the sample where the arbitrage profit for the strategy was negative. Total observations for each security are provided in the final row of each panel.

Panel A: Filter $0.50

Profit	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Total	$11,398	$9,313	$14,112	$16,417	$7,289	$5,827	$6,592	$23,527	$17,168	$12,405
Max	$12,175	$39,934	$14,236	$16,566	$11,909	$32,64	$9,162	$25,462	$17,717	$19,981
Min	($4,777)	($18,674)	$0	($283)	($3,786)	($2,253)	$0	$0	$0	($3,308)
Std Dev	$3,233	$3,982	$3,282	$3,629	$2,128	$6,603	$2,183	$5,974	$4,798	$3,979
Obs < 0	37	98	0	7	1	2	0	0	0	16
Obs	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253

Panel B: Filter $1.00

Profit	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Total	$5,456	$3,101	$7,158	$9,154	$2,099	$1,114	$1,405	$13,100	$7,690	$5,586
Max	$5,499	$10,202	$8,064	$9,300	$4,416	$6,285	$2,442	$13,834	$8,082	$7,569
Min	($1,658)	($4,111)	$0	($2,106)	$0	($1,305)	($30)	$0	$0	($1,023)
Std Dev	$1,536	$105	$1,702	$1,981	$787	$1,121	$519	$3,122	$2,176	$1,553
Obs < 0	13	18	0	8	0	15	2	0	0	6.22
Obs	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253

Panel C: Filter $2.00

Profit	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Total	$739	$733	$2,185	$6,108	$708	$512	$81	$4,333	$1,323	$1,858
Max	$744	$752	$2,600	$6,787	$2,482	$2,435	$248	$4,339	$1,361	$2,416.62
Min	($35)	$0	$0	($996)	$0	($509)	($8)	($55)	$0	($178.15)
Std Dev	$201	$168	$483	$1,386	$439	$403	$43	$973	$399	$499.49
Obs < 0	1	0	0	8	0	3	7	3	0	2.44
Obs	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253

Panel D: Filter $3.00

Profit	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Total	$5,456	$3,101	$7,158	$9,154	$2,099	$1,114	$1,405	$13,100	$7,690	$5,586.32
Max	$5,499	$10,202	$8,064	$9,300	$4,416	$6,285	$2,442	$13,834	$8,082	$7,569.43
Min	($1,658)	($4,111)	$0	($2,106)	$0	($1,305)	($30)	$0	$0	($1,023.28)
Std Dev	$1,536	$1,035	$1,702	$1,981	$787	$1,121	$519	$3,122	$2,176	$1,553.37
Obs < 0	0	0	0	6	0	7	0	1	3	1.89
Obs	1149	1447	953	1447	1447	1447	1447	970	970	1253

TRADING RULES WITH TRANSACTION COSTS

Next, we incorporate trading costs into the analysis. It is well known that the imposition of trading costs can negate profits available from many apparent arbitrage strategies. In this section we test to determine if the previously identified arbitrage opportunities persist in the presence of trading costs. Table 5 and Table 6 report the results of the trading rule under two different assumptions regarding transaction costs.

Table 5 assumes 1% transaction costs per trade. Each panel in the table summarizes the arbitrage profit, the number of transactions implemented, the dollar transaction costs for the strategy and the total number of observations for each security. Table 6 presents identical information under the assumption of 2% transaction costs per trade. Each panel contains summary results for trading rules based upon price differences between identical securities traded on exchanges in both Stockholm and New York. The size of the filter is listed at the top left-hand side of each panel. For example, the first panel reports the results from trades which were initiated when the price difference between exchanges was + or -$0.50. The dollar amount per trade is $1,000 for each panel. The columns provide summary data for each cross-listed company included in the sample. The arbitrage profit row represents the accumulated profit from implementing this rule. The number of transactions implemented within each combination of filter and trade amount is listed for each security. Each row reports the number of days in the sample where the arbitrage profit for the strategy was negative. Total observations for each security are provided on the final row of each panel.

The evidence presented in Table 5 indicates that when transaction costs equal 1%, the majority of the cross-listed stocks still produce an arbitrage profit. Using a $0.50 filter resulted in arbitrage profits for each of the nine stocks in our sample. Filters of $1.00 and $2.00 each produced arbitrage profits for eight of the nine stocks and the average profit per security was positive. In each of these panels we see a negative strategy profit for MAXM. A filter of $3.00 produced arbitrage profits for eight of nine securities and no negative profits. Interestingly, the average arbitrage profit declined as the filter window widened.

When transaction costs increase to 2%, we see that the persistence of arbitrage profits wanes somewhat. Table 6 indicates that a $0.50 filter produces profits in only three of nine cases with an average loss per security of ($1,181.70). A filter of $1.00 is more successful with profits in six of nine cases and an average profit per security of $1,075. The average profit is also positive when a filter of $2.00 or $3.00 is used. Each of these filters produced profits for seven of nine stocks.

Table 5: Trading Rule Results with 1 Percent Transaction Cost

Each panel contains summary results for trading rules based upon price differences between identical securities traded on exchanges in both Stockholm and New York. The size of the filter is listed at the top left-hand side of each panel. The dollar amount per trade was $1,000 in each market. The columns provide summary data for each cross-listed company included in the sample. The arbitrage profit row represents the accumulated profit from implementing this rule. The number of transactions implemented for each security. Total observations for each security are provided on the final row of each panel.

Panel A: Filter $0.50, 1% Transaction Cost										
	AZN	**ALV**	**BCOR**	**ELUX**	**ERICY**	**MAXM**	**OXGN**	**TLTOA**	**SWMAY**	**Average**
Profit Total	$2,518	$2,253	$6,212	$9,137	$3,309	$767	$4,452	$14,567	$7,288	$5,612
Number of Transactions	444	353	395	364	199	253	107	448	494	340
Dollar Transaction Costs	$8,880	$7,060	$7,900	$7,280	$3,980	$5,060	$2,140	$8,960	$9,880	$6,793
Observations	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253
Panel B: Filter $1.00										
	AZN	**ALV**	**BCOR**	**ELUX**	**ERICY**	**MAXM**	**OXGN**	**TLTOA**	**SWMAY**	**Average**
Profit Total	$2,696	$1,621	$4,178	$7,494	$939	-$846	$965	$9,000	$3,930	$3,331
Number of Transactions	138	74	149	83	58	98	22	205	188	113
Dollar Transaction Costs	$2,760	$1,480	$2,980	$1,660	$1,160	$1,960	$440	$4,100	$3,760	$2,256
Observations	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253
Panel C: Filter $2.00										
	AZN	**ALV**	**BCOR**	**ELUX**	**ERICY**	**MAXM**	**OXGN**	**TLTOA**	**SWMAY**	**Average**
Profit Total	$539	$673	$1,685	$5,828	$288	-$128	$61	$3,173	$843	$1,440
Number of Transactions	10	3	25	14	21	32	1	58	24	21
Dollar Transaction Costs	$200	$60	$500	$280	$420	$640	$20	$1,160	$480	$418
Observations	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253
Panel D: Filter $3.00										
	AZN	**ALV**	**BCOR**	**ELUX**	**ERICY**	**MAXM**	**OXGN**	**TLTOA**	**SWMAY**	**Average**
Profit Total	$204	$673	$506	$5,618	$397	$112	-	$1,029	$237	$975
Number of Transactions	2	3	5	8	9	9	-	17	7	7
Dollar Transaction Costs	$40	$60	$100	$160	$180	$180	$-	$340	$140	$133
Observations	1,149	1,447	953	1,447	1,447	1,447	1,447	970	970	1,253

Table 6: Trading Rule Results with 2 Percent Transaction Cost

Each panel contains summary results for trading rules based upon price differences between identical securities traded on exchanges in both Stockholm and New York. The size of the filter is listed at the top left-hand side of each panel. The dollar amount per trade was $1,000 in each market. The columns provide summary data for each cross-listed company included in the sample. The arbitrage profit row represents the accumulated profit from implementing this rule. The number of transactions implemented for each security. Total observations for each security are provided on the final row of each panel.

Panel A: Filter $0.50, 2% Transaction Cost

	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Profit Total	-$6,362	-$4,807	-$1,688	$1,857	-$671	-$4,293	$2,312	$5,607	-$2,592	-$1,182
Number of Transactions	444	353	395	364	199	253	107	448	494	340
Dollar Transaction Costs	$17,760	$14,120	$15,800	$14,560	$7,960	$10,120	$4,280	$17,920	$19,760	$13,587
Observations	1149	1447	953	1447	1447	1447	1447	970	970	1253

Panel B: Filter $1.00

	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Profit Total	-$64	$141	$1,198	$5,834	-$221	-$2,806	$525	$4,900	$170	$1,075
Number of Transactions	138	74	149	83	58	98	22	205	188	113
Dollar Transaction Costs	$5,520	$2,960	$5,960	$3,320	$2,320	$3,920	$880	$8,200	$7,520	$4,511
Observations	1149	1447	953	1447	1447	1447	1447	970	970	1253

Panel C: Filter $2.00

	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Profit Total	$339	$613	$1,185	$5,548	-$132	-$768	$41	$2,013	$363	$1,022
Number of Transactions	10	3	25	14	21	32	1	58	24	21
Dollar Transaction Costs	$400	$120	$1,000	$560	$840	$1,280	$40	$2,320	$960	$836
Observations	1149	1447	953	1447	1447	1447	1447	970	970	1253

Panel D: Filter $3.00

	AZN	ALV	BCOR	ELUX	ERICY	MAXM	OXGN	TLTOA	SWMAY	Average
Profit Total	$164	$613	$406	$5,458	$217	-$68	N/A	$689	$97	$842
Number of Transactions	2	3	5	8	9	9	N/A	17	7	7
Dollar Transaction Costs	$80	$120	$200	$320	$360	$360	N/A	$680	$280	$267
Observations	1149	1447	953	1447	1447	1447	1447	970	970	1253

CONCLUSIONS

In this paper we examine the relative efficiency of the U.S. and Swedish Stock Exchanges. Numerous stocks are cross-listed on United States Exchanges and the Swedish Stock Exchange. We compare the prices of these firms at near-simultaneous trading time. This study is an extension of an earlier work by Jalbert, Moritz and Stewart (2005), who completed an efficiency test on stocks that are cross-listed on the Stockholm and a U.S. stock exchange, finding evidence of an inefficient market. This paper extends this line of work by conducting a trading rule test to provide additional evidence on the efficiency of these markets. We develop a trading rule whereby arbitrage profits might be earned. We find the trading rule produces abnormal returns both without transaction costs and when incorporating transaction costs. Though as one would expect, higher transaction costs reduce the number and magnitude of arbitrage profits. The results hold regardless of the level of the filter. Thus the results here provide additional evidence of market efficiency issues between the Stockholm and U.S. exchanges.

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OPEN MARKET OPERATIONS AND THE PRICE OF LIQUIDITY: THE CASE OF THE CZECH REPUBLIC BETWEEN 1998 AND 2004

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ABSTRACT

Effective monetary policy depends on the ability of central banks to stabilize fluctuations of overnight interest rates around their policy rate. The function of the stabilization mechanism involves balancing aggregate bank demand for reserves with the central bank's supply of reserves in the interbank market. This paper discusses the main sources of temporal gaps between the demand for and the supply of reserves and their impact on overnight interest rate volatility. A theoretical explanation of the role of intertemporal substitution in periods of fluctuating reserves demand is provided. Crucial features of central bank targeting of overnight interest rates are discussed. The behavior of overnight interest rates in the Czech interbank market (1998-2004) is empirically examined in the context of excess liquidity. Some relevant structural changes in the interbank market are identified. Specifically, we find undershooting of the non-stability of excess liquidity in the interbank market and a sharp decline of overnight interest rate volatility associated with the introduction of intraday credit.

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INTRODUCTION

Like the European Central Bank (ECB) and U.S. Federal Reserve System (Fed), the Czech National Bank (CNB) places a strong emphasis on the price of bank reserves traded within open market operations. In the case of CNB, the price of these highly-liquid resources is a fortnightly (bi-weekly) limit repo rate. This fortnightly repo rate acts as the upper limit of interest rates in banks bids for transient deposits of excess liquidity in daily CNB repo tenders.

Our previous study (see Brada, Bruna 2004) indicated that the actual level of the repo rate was, to a limited extent, a determinant of the dynamics of short-term interest rates in the Czech interbank market. The spread between the repo rate and interest rates may become relatively large while quantitatively significant deviations from the repo rate are a relatively long-term phenomenon. On the other hand, in ultra-short interest rates, overnight (O/N), seven day (7D) and fortnight (14D), the actual level of the repo rate seems to constitute a center of gravity that restricts fluctuations of these rates around the repo rate. This center of gravity limits potential deviations of ultra-short interest rates from the repo rate to be of transient character only.

The causes of different interest rate behaviors lie in the way CNB's involves itself in ultra-short maturity trading. CNB directly influences the price of the most liquid resources in the money market by announcing the explicit repo rate level. In addition, through repo tenders, CNB ensures an amount of liquidity for the banking sector that eliminates the existence of a longer-term deficits or excess bank reserves. Such deficits and excess could cause ultra-short interest rates to deviate significantly from the longer run repo rate.

The objective of this study is to examine the main aspects of a mechanism that efficiently stabilizes ultra-short interest rates in the proximity of the repo rate in the money market. Further, the relationship between errors in CNB liquidity prediction and development of O/N interest rates in the Czech interbank market is analyzed and tested. Stabilizing

BASIC RELATIONS BETWEEN INTEREST RATES IN THE MECHANISM STABILIZING ULTRA-SHORT INTEREST RATES

It is assumed that at a time *t* agents in the money market compare the actual size of the quoted *n*-day interest rate with the expected future development of O/N interest rates in the run of subsequent *n* days. In the longer contract maturity, market participants require an increasing reward in the form of a term premium. The resulting equilibrium in the money market can be expressed as the equilibrium of a speculator who, on the basis of available information (Ω_t), quotes actual *n*-day interest rate (IR_t^n) as the sum of the expected average level of O/N interest rates in the period *t* to *t+k* ($IR_t^{O/N,e}$, $IR_{t+1}^{O/N,e}$, ..., $IR_{t+k}^{O/N,e}$) and term premium (ρ_t^n):

$$IR_t^n = \frac{1}{n}\sum_{k=0}^{n-1} IR_{t+k}^{O/N,e}\Big|\Omega_t + \rho_t^n . \qquad (1)$$

It is also assumed that the central bank uses the announced *s*-day interest rate ($REPO_t^s$) as the main monetary-policy interest rate when the maturity of this rate (the repo rate) equals at maximum, the maturity of ultra-short rates (i.e. $s \le n$). In this case, the market O/N interest rate represents the repo rate. The announced level of the repo rate usually corresponds to the average effective O/N interest rate in the interbank market over several trade days. In case the market O/N interest rate represents the repo rate, the announced level of the repo rate usually corresponds to the average effective O/N interest rate in the interbank market over several trade days. On the contrary, if the repo rate is a specific interest rate, exclusively used in central bank monetary operations, then the announced level of the repo rate usually corresponds to the limit (minimum or maximum) level of the effective repo rates in periodic tenders for the supply or the withdrawal of liquidity.

The mechanism stabilizing ultra-short interest rates is understood to be a continuous process. This continuous process results in a situation where the average level of ultra-short interest rates copies the course of the repo rate. Quantitatively more significant deviations of these rates from the repo rate are of transient character only. This process occurs when agents in the money market are convinced that the average spread between expected O/N interest rates and the actual and expected level of the repo rate will approach zero in the run of future *n* days:

$$\frac{1}{n}\sum_{k=0}^{n-1}(IR_{t+k}^{O/N,e} - REPO_{t+k}^{s,e})\Big|\Omega_t = p\,,\;\; p \to 0 \qquad (2)$$

With the existence of supplementary instruments of monetary policy in the form of deposit and lending facilities it is possible to identify lower and upper fluctuation limits of expected O/N interest rates. Moreover, it is possible to estimate a minimum volatility of the spread between expected O/N interest rates and the repo rate. Decreases in O/N interest rates should stop at the level of the O/N interest rate at deposit facilities. On the contrary, an increase in O/N interest rates should reach a maximum at the level of O/N interest rate from the lending facility.

O/N interest rates indicate the price of money in the interbank market and play a key role in the bank's liquidity position management. It is assumed that O/N interest rates will fluctuate more or less symmetrically around the repo rate. This fluctuation is in relation to day-to-day differences between the central bank's supply of reserves and aggregate demand of banks for reserves. It does not mean that volatility cannot assume high values. The supply of the central bank's reserves is based on a prediction of the volatile demand function. During the trading day, the money market is subject to liquidity shocks related to changes in the demand for reserves. These liquidity shocks can have a large influence on the actual volume of banking system reserves.

Nevertheless, it is assumed that the volatility of the spread between expected O/N interest rates and the repo rate will be lower in cases when the central bank carries out open market operations with daily frequency (like operations of the Fed or CNB). Day-to-day adjustments allow the bank to respond more quickly to changes in demand for reserves than less frequent adjustments. The volatility of the spread is expected to be lower if the central bank uses the one-day repo rate because it is possible to directly stabilize the O/N interest rate around the repo rate. By comparison, when the central bank operates with seven-day or fortnight repo rates, stabilization of O/N interest rate fluctuations is not the focus of its attention.

DETAILED SPECIFICATION OF STABILIZATION MECHANISM INVOLVED IN FUNCTIONS OF DEMAND FOR RESERVES AND SUPPLY OF RESERVES

Detailed specification of the ultra-short interest rate stabilization mechanism occurs because dynamics of O/N interest rates may be substantially influenced. This influence occurs from banks trading to meet minimum reserve requirements with the central bank (see e.g. Bindseil, Seitz, 2001; Prati, Bartolini, Bertola, 2002 or Gaspar, Quirós, Mendizábal, 2004). From the viewpoint of aggregate demand for reserves by banks, minimum reserve requirements determine the minimum average balance of reserves held with the central bank. In this context Hamilton (1996), Taylor (2001) and Bartolini, Bertola, Prati (2001 and 2002) discussed a simple model of demand for reserves in which banks carry out intertemporal substitution of demand for reserves aimed at minimizing the cost of holding reserves. The principle of this substitution is that banks limit the holding of reserves on days when the money market is characterized by relatively high demand for reserves and high prices. They hold excess reserves on days when excess liquidity is present in the market and reserves are cheaper. In this model agents in the money market speculate on expected changes in O/N interest rates on any two consecutive days. They change their actual demand for reserves in relation to an expected change in the O/N interest rate on the following day.

The result of this speculation is a change in the relationship between demand and supply in the money market. This change in demand is immediately reflected in variations in actual O/N interest rates. The expectation of a decrease (increase) in tomorrow's O/N interest rate leads to a decrease (increase) in the actual O/N interest rate. Under equilibrium in the money market, the actual level of the O/N interest rate corresponds exactly to the expected next day level of the O/N interest rate:

$$IR_t^{O/N} = IR_{t+1}^{O/N,\,e} \Big| \Omega_t \qquad (3)$$

The above-mentioned conditions do not hold in all circumstances. The model noted above was derived from operations in the U.S money market where the price of reserves traded in open market operations corresponds to the actual level of the O/N interest rate. In situations where the central bank uses the repo rate with longer than O/N maturity as the main monetary-policy tool, both the absolute price of funds in the money market and the price of funds deposited with the central bank are important.

If the actual spread between the expected O/N interest rate and the repo rate is positive, banks may view resources in the money market to be expensive. On the contrary, if the spread is negative, reserves may seem cheap. An expected decrease in the spread between two trading days may therefore imply that banks will temporarily change the actual demand for reserves. An expected decrease in the positive (negative) spread between two trade days may therefore implies that banks will temporarily increase (decrease) the actual demand for reserves. They will try to decrease (increase) the balance of reserves below (above) the level corresponding to the minimum reserve requirement.

If banks expect a change in the repo rate along with a change in the spread, movements of the actual O/N interest rate are determined in parallel. First, changes in the spread between the expected O/N interest rate for the current day and the actual and expected next day repo rate affect the spread. Second the related expected change in the O/N interest rate between the actual and the next trade day affect the spread. This suggests that expected changes in the repo rate will be accompanied both by changes in the price at which the central bank will carry out its open market operations and in the price around which the level of future ultra-short interest rates will be stabilized effectively.

When this parallel situation occurs, equilibrium in the money market occurs at the point where the size of the expected spread between the O/N interest rate and the repo rate for the actual day corresponds to the size of the expected spread between both interest rates for the next day. When both spreads are equal, the average spread *p* is defined as:

$$(IR_{t}^{O/N,e} - REPO_{t}^{s})\big|\Omega_{t} = (IR_{t+1}^{O/N,e} - REPO_{t+1}^{s,e})\big|\Omega_{t} = p \qquad (4)$$

A number of authors have documented that variations in O/N interest rates are sometimes easy to predict (see e.g. Hamilton, 1996; ECB, 2002; Würtz, 2003; Gaspar, Quirós, Mendizábal, 2004; FRBNY 2004 and Prati, Bartolini, Bertola, 2002). This situation contradicts the above equilibrium condition. In fact, the intertemporal substitution of reserves is not strong enough to suppress systematic features in the behavior of O/N interest rates. Calendar effects are mentioned most frequently when O/N interest rates vary according to a certain day on which a specific trade day falls (e.g. the last or the first working day of the week, the last day of the month, quarter or year, etc.). In addition, a systematic increase in the size and variability of the spread between O/N interest rates and the repo rate can be seen on the last days of the maintenance period in some markets.

One reason predictable movements of the spread between O/N interest rates and the repo rate persist may be that the main motive of banks trading in the money market is not to minimize the costs of holding reserves but rather to continuously hold bank reserves. In the context of individual and aggregate liquidity shocks, such reserves enable the bank to cope with potential fluctuations in the need for reserve resources during the course of a trading day.

Individual liquidity shocks result because of the need to clear payments within the interbank payments system. Hence these shocks do not have an immediate impact on the level of aggregate demand for reserves. However, full dependence of banks on external liquidity resources may be too costly or risky because it makes banks trade in the money market even if conditions are not favorable. This risk may lead to the holding of standby reserves and reduce the need for day-to-day speculation in O/N interest rate movements. As indicated by Bindseil, Seitz, 2001; ECB, 2002; and FRBNY, 2004, variance between the expected and actual development of net government revenues within a day may be an important source of instability of O/N interest rates.

The maintenance period has two phases. In the first phase of the maintenance period the average balance in the account of reserves is often below the minimum level required. In the second phase of the maintenance period banks increase their demand for reserves (see e.g. ECB, 2002; FRBNY, 2004). Therefore, in the first phase of the maintenance period the size and volatility of the spread between O/N interest rates and the repo rate is very low. The volume of transactions in the interbank market is relatively low, and banks do not experience a liquidity deficit in the market (see e.g. Prati, Bartolini, Bertola, 2002).

In the second phase of the maintenance period, a deficit of liquidity frequently occurs in the banking system. Banks must accumulate larger volumes of reserves to meet minimum reserve requirements. It is no longer easy to counterbalance negative liquidity shocks by decreasing funds in the reserves account. In these instances, the bank may be fined for failure to meet minimum reserve requirements. For this reason, it is logical for banks to increase their reserve balance above the minimum reserve requirement to accommodate any negative aggregate liquidity shock. A high demand for reserves at the end of the maintenance period could cause the average size of the spread and volatility between O/N interest rates and the repo rate to increase.

The intensity of O/N interest rate movements is also dependent on the extent to which the central bank accommodates the supply of reserves in open market operations. Central banks usually have concerns about changing their supply of reserves according to movements in the demand for reserves (see e.g. CNB, 2004; ECB, 2004; FRBNY, 2004). The Central Banks goal is to prevent instability in the demand for reserves which could result in a quantitatively significant deficit or excess of liquidity in the money market. Such an excess or deficit in liquidity would destabilize movements of O/N interest rates.

Changes in the supply of reserves of central banks are based on predictions of bank demand for reserves for a specific time period. The length of the time period is influenced by the frequency of open market operations. The variability of reserve demand influences the way the central bank moves its supply of reserves to the money market. Changes in the demand for reserves in an ultra-short or short period are usually satisfied by transient changes in liquidity through repo operations with short-term maturity securities. Lasting changes in the demand for reserves may be satisfied by changing the standing supply of liquidity through spot purchases and sales of securities. Open market operations are commonly conducted once per day in the morning hours by means of a short tender between the central bank and selected commercial banks.

The supply of reserves is usually maintained with the goal of accommodating changes in the demand for reserves. These changes in the demand for reserves result from dynamics associated with satisfaction of minimum reserve requirements and from the influence of aggregate liquidity shocks. A critical issue for O/N interest rates is if central banks fully respond to the demand for excess reserves. Calendar effects and pressures for an increase in O/N interest rates at the end of the maintenance period suggest that central banks satisfy only a portion of the demand for excess reserves through open market operations. If this is the case, a relatively large portion of the demand for reserves may remain unsatisfied causing large errors in liquidity prediction. These prediction errors may be reflected in certain systematic movements of O/N interest rates.

SIMPLE ECONOMETRIC MODEL OF THE MECHANISM STABILISING THE SPREAD BETWEEN ULTRA-SHORT INTEREST RATES AND REPO RATES

The aggregate demand of banks for reserves (R_t^D) and supply of reserves of the central bank (R_t^S) can be modeled as follows, where the variables are defined in Table 1:

$$R_t^D = MRR_t^{D,e} + ER_t^{D,e} + AF_t^{D,e} + OMO_{t-k} + \alpha\left[(IR_t^{D,O/N,e} - REPO_t^s) - (IR_{t+1}^{D,O/N,e} - REPO_{t+1}^{D,s,e})\right] + u_t \quad (5)$$

$$R_t^S = MRR_t^{S,e} + ER_t^{S,e} + AF_t^{S,e} + OMO_{t-k} + \beta(IR_t^{S,O/N,e} - REPO_t^s - p) + v_t \quad (6)$$

Table 1: Definition of Variables

$MRR_t^{D,e}$ and $MRR_t^{S,e}$	express the expectations of banks and the central bank concerning the closing balance on the account of reserves for the purposes of satisfaction of minimum reserve requirement for a given trade day *t*,
$ER_t^{D,e}$ and $ER_t^{S,e}$	the expectations of banks and the central bank concerning the level of excess reserves.
$AF_t^{D,e}$ and $AF_t^{S,e}$	are the expectations of banks and the central bank concerning the influence of autonomous factors.
OMO_{t-k}	the volume of the open market operations with *k*-day maturity, which falls on actual day. α (α > 0) is the parameter for the sensitivity of demand for reserves to the change in the spread between O/N interest rates and the repo rate expected by banks.
$\left[(IR_t^{D,O/N,e} - REPO_t^s) - (IR_{t+1}^{D,O/N,e} - REPO_{t+1}^{D,s,e})\right]$	the product of both factors, expresses the significance of intertemporal substitution of banks for the demand for reserves).
β	a parameter indicating the sensitivity of the supply of reserves to the deviation of O/N interest rates from the repo rate expected by the central bank $(IR_t^{S,O/N,e} - REPO_t^s - p)$ for actual day.
u_t and v_t	random errors with standard characteristics

The values β are influenced by the intensity of direct O/N interest rate stabilization carried out by the central bank and by its willingness to cover changes in the demand for reserves. In this scenario, the error of liquidity prediction by the central bank can be expressed by the function:

$$(R_t^S - R_t^D) = (MRR_t^{S,e} - MRR_t^{D,e}) + (ER_t^S - ER_t^{D,e}) + (AF_t^{S,e} - AF_t^{D,e}) + \beta(IR_t^{S,O/N,e} - REPO_t^s - p) - \\ - \alpha\left[(IR_t^{D,O/N,e} - REPO_t^s) - (IR_{t+1}^{D,O/N,e} - REPO_{t+1}^{D,s,e})\right] + (v_t - u_t) \quad (7)$$

It is assumed that errors in liquidity prediction are composed of purely random errors in estimating the satisfaction of minimum reserve requirements. However other errors are also possible. These errors include errors in estimating the influence of autonomous factors, different expectations of O/N interest rate development, systematic errors in estimating the satisfaction of excess reserves and the central bank's low sensitivity to speculative changes in the demand for reserves. It is argued in this research that the time series of liquidity prediction errors is a stationary process with zero mean and constant variability that may exhibit some signs of serial correlation.

When modeling the spread between O/N interest rates and the repo rate for actual trade days, a change in the spread is a function of liquidity prediction errors. Even though the volume of liquidity supplied or withdrawn by the central bank cannot be higher than total demand of banks for reserves or the supply of excess reserves, it is argued here that even positive liquidity prediction errors may signal changes in the money market. This occurs because the central bank has better information on the demand for reserves, by virtue of the cash fulfillment of state budgets, and may foresee either future reserve deficits or excesses.

In addition, it is possible to identify the existence of some regularity in the behavior of the spread between O/N interest rates and the repo rate in the form of calendar effects and maintenance period end effects. Variations in the spread between these interest rates may show some features of an autoregression process if prediction errors are serially correlated. Information on individual bank expectations of the level of O/N interest rates is not available so questions about the influence of bank speculation on movements of O/N interest rates can not easily be tested. Variations in the spread between O/N interest rates and the repo rate are modeled as follows, where the variables are defined in Table 2:

$$\Delta(IR_t^{O/N} - REPO_t^s) = \sum_{q=1}^{r}\lambda_q \Delta(IR_{t-q}^{O/N} - REPO_{t-q}^s) + \pi(R_t^S - R_t^D) + \sigma^i D^i + \sum_j^J \sigma_j^i D_j^i + e_t \quad (8)$$

Table 2: Definition of Variables

$\sum_{q=1}^{r}\lambda_q \Delta(IR_{t-q}^{O/N} - REPO_{t-q}^s)$	expresses the autoregression process of variation in the spread between O/N interest rate and the repo rate of *r*-th degree
λ_q $(-1 < \lambda_q < 1)$	parameters of this process
Rr	expresses the rate of inertia of the change in the spread between O/N interest rates and the repo rate
π $(-1 < \pi < 1)$	measures the sensitivity of the spread change to the actual error of liquidity prediction
D^i	a dummy variable taking the value one if the actual trade day falls on the i-th day of the maintenance period
I	the number of days in the maintenance period
σ_j^i	measures the intensity of the influence of the j-th calendar effect on the change in the size of the spread between these interest rates,
D_j^i	a dummy variable assuming the value one if at the i-th day of the maintenance period the j-th calendar effect occurs
J	the number of calendar effects
e_t	a random error term

ANALYSIS OF LIQUIDITY PREDICTION ERRORS IN REPO OPERATIONS OF CNB

Unlike the other central banks, CNB withdraws excess liquidity from the money market during open market operations. Thus, repo operations are a simple agreement between CNB and other banks to secure the claim of a bank against CNB by transfer of debt securities. Repo operations are carried out in the form of American type repo tenders. CNB demands liquidity in the money market and banks make bids to deposit excess reserves with CNB. CNB invites the repo tender every trading day at about 9.30 a.m. The results of the repo tender are announced regularly at 10.00 a.m. In response, banks that win the bid create a deposit with CNB.

The repo tender of CNB can be viewed as a special form of auction with a variable interest rate. The total volume of withdrawn liquidity is not known to banks in advance. This auction procedure gives banks an opportunity to make their bids to CNB to create a deposit with a fixed fortnight maturity. In submitting their orders, banks specify not only the amount but also the price of money to be deposited with CNB. The level of the announced repo rate limits the required interest rate.

In the examined period 1998-2004(2Q), 1642 repos from the Czech National Bank (CNB) tenders were conducted. An overwhelming majority of these repo tenders absorbed excess liquidity from the money market. The policy of covering changes in the supply of reserves and interest rate targeting was accompanied by errors in prediction of the excess liquidity volume in the market (see Figure 1). The supply of excess liquidity of banks was unsatisfied on average on the level of 10% (see Figure 2). Figure 2 also shows that the level of unsatisfied supply of excess liquidity is quite unstable. In this case, banks are faced with the risk of re-balancing their liquidity position with potential effects on equilibrium O/N interest rate.

Figure 1: Errors of Liquidity Prediction by CNB (Day Data)

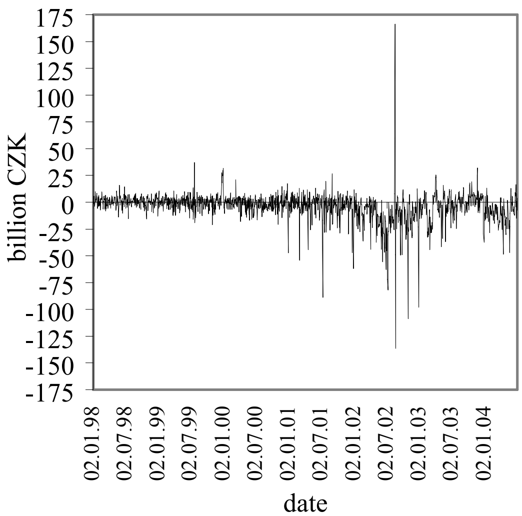
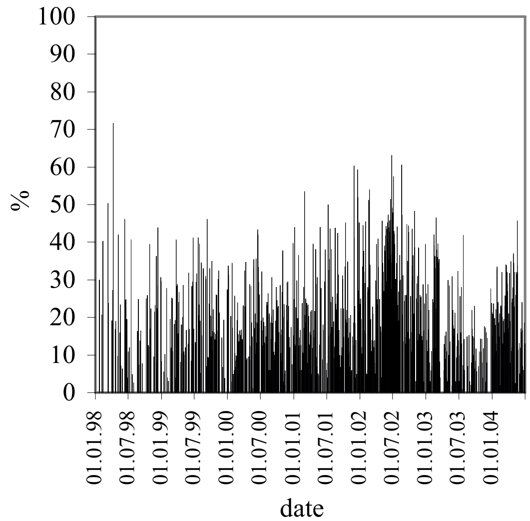


Figure 2: The Volume of Unsatisfied Supply of Excess Liquidity of Banks (Day Data)

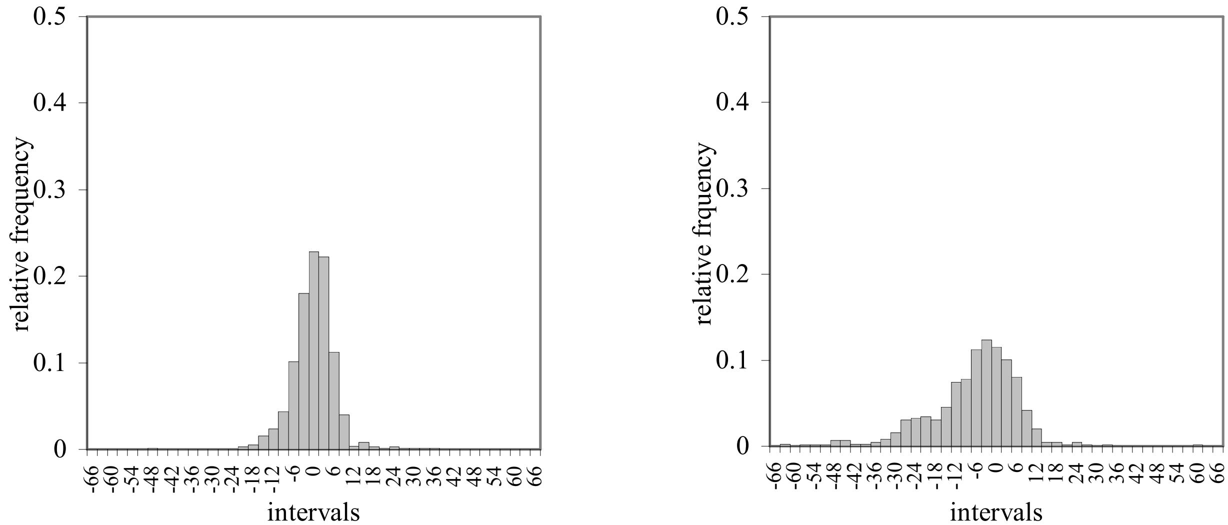


The analysis of liquidity prediction errors shows that the period examined can be divided into two subsets. In these two subsets, the prediction errors have different statistical characteristics. From 1998-2000 (see Figure 3a and Table 3), prediction errors are relatively small and they are distributed very close to zero. The variability of prediction errors is relatively low and the frequency of extreme values is low. Distribution of frequencies is almost perfectly symmetric with relatively higher frequency of values close to the average error prediction. Analysis of the sampling partial autocorrelation function indicates that the process generating the time series of liquidity prediction errors is an AR(0) process, where prediction errors are random and are not serially correlated.

Beginning in 2001 (see Figure 3b and Table 3) the size of prediction error increases markedly, and the errors are no longer concentrated in the proximity of zero. On the contrary, CNB systematically underestimates the amount of excess liquidity supply. The results are significant at the 1% significance level using a Mann-Whitney test (the absolute value of the test criterion z is 11.608). Simultaneously, variability of prediction errors increases markedly. There is an increase in the frequency of extreme values and their distance from zero. The symmetry of the frequency distribution around the mean does not change significantly, but the kurtosis of the distribution increases. Moreover, the partial autocorrelation function indicates that the process generating liquidity prediction errors has transformed to an AR(2) process, where actual prediction errors are correlated with prediction errors from two preceding trade days.

Figure 3a and 3b: Relative Frequencies of Liquidity Prediction Errors (Day Data, Interval Size = 6 Billion CZK)

a) 1998-2000 b) 2001-2004(2Q)



Changes in the characteristics of excess reserve predictions in the money market are connected with a rapid increase in the volume of withdrawn liquidity in 2001 and 2002. This withdrawal was an immediate response to frequent intervention in the foreign exchange market by CNB during the period. The average level of bank claims against CNB increased from around 250 billion CZK in November 2000 to around 500 billion CZK in November 2002. Intervention in the exchange rate market allowed CNB to satisfy the high demand for Czech crown for a short time. However, this resulted in resources in the money market for which there was not an appropriate long-term use in the banking sector. The volume of reserve requirement account deposits were a little more than 5% of total banking sector deposits with CNB. The amount of excess reserves is lower by an order. These resources are returned to CNB in repo operations as excess liquidity.

The reasons for systematic underestimation of excess liquidity supply are somewhat unclear. It could be explained by CNB reducing the volume of withdrawn liquidity and thereby decreasing the high interest costs of repo operations. The underestimation of excess liquidity could also be connected to growth of variability in liquidity prediction errors. These prediction errors occur when CNB did not respond flexibly enough to increases in the volatility of excess liquidity supply on the banking sector side.

Table 3: Main Characteristic of Liquidity Prediction Errors

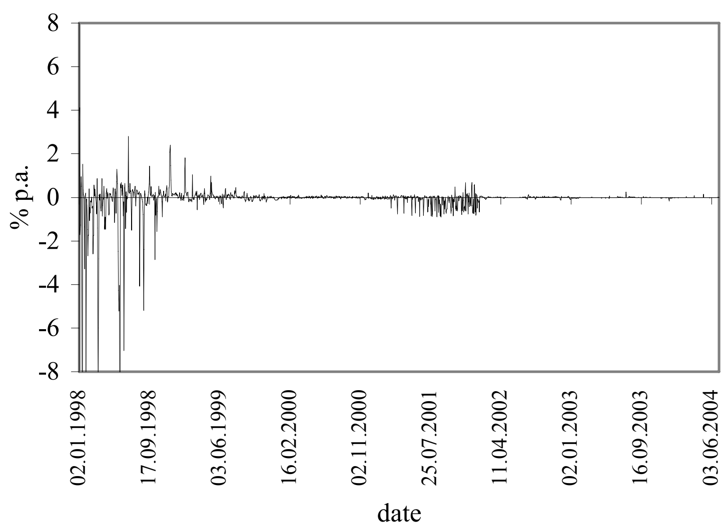
	1998-2000	**2001-2004(2Q)**
Mean	-0.094	-6.711
Standard errors	6.343	16.475
Skewness	-0.014	0.068
Kurtosis	7.509	24.294
Minimum	-47.254	-136.410
Maximum	37.164	166.430

ANALYSIS OF THE STABILISATION MECHANISM OPERATION IN THE CZECH INTERBANK MARKET

The development of ultra-short interest rates in the Czech money market is documented through an example. The example involves interest rates O/N PRIBOR (Prague Interbank Offered Rate). The overnight PRIBOR reference rates express the simple arithmetic mean of offer interest rates quoted by the most important market makers in the interbank market between 10.30 and 10.45 a.m. PRIBOR is determined with a 15-30 min delay after the results of the repo tender are announced. As determination of the PRIBOR rate begins, PRIBOR may immediately reflect the liquidity prediction errors of CNB.

Figure 4 shows that the spread between O/N PRIBOR and the repo rate was highly volatile in 1998 and in the first six months of 1999. From the last third of 1999 to the end of the examined period these rates were stabilized close to the level of the announced repo rate. This change in behavior of ultra-short interest rates was an immediate consequence of the introduction of intraday credit by CNB on August 3, 1999. With this introduction, banks were given the opportunity to use an interest-free credit from CNB during the trading day in the event of a reserve shortage. Banks were required to return all resources used during the trading day to the CNB account before the end of the trading day. If not returned, the intraday credit automatically becomes a loan with potentially higher interest rates than the O/N interest rate.

Figure 4: The Spread between O/N PRIBOR and the Repo Rate (1998-2004(2Q), Day Data)

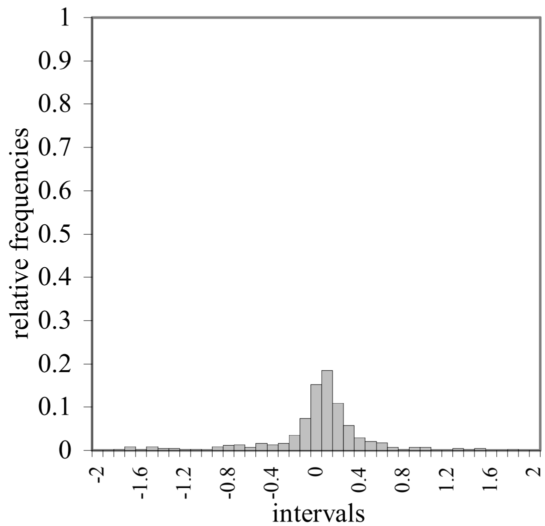


Before intraday credit was introduced (see Figure 5a and Table 4), the average level of O/N PRIBOR was 20 basis points below the level of the repo rate. In this period extreme deviations of O/N PRIBOR from the repo rate occurred. Specifically noteworthy is the great repo rate undershooting of 1998. High variability in the spread between O/N PRIBOR and the repo rate is also clearly identified. Analysis of the autocorrelation function and partial autocorrelation function indicates the existence of serial autocorrelation and suggests that the process generating the spread between O/N PRIBOR and the repo rate is an MA(4) process. The distribution of frequencies is slightly negatively skewed.

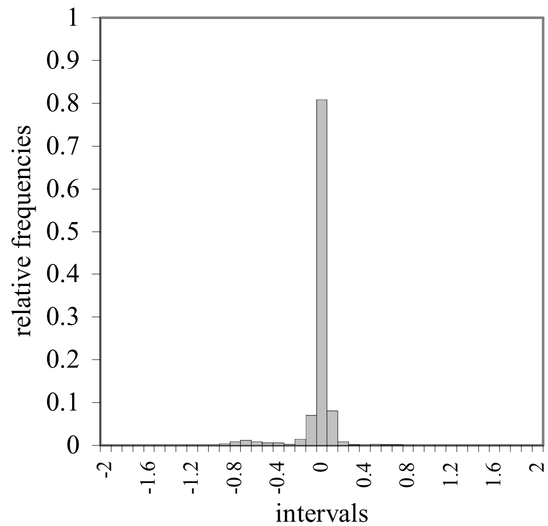
With the introduction of intraday credit, the average level of O/N PRIBOR approached the level of the repo rate (see Figure 5b and Table 4). A Mann-Whitney test confirms this movement is statistically significant at the 1% significance level (the absolute value of the test criterion z is 7.814). On the contrary, extreme values of the spread do not exceed 100 basis points in absolute terms. Moreover, this situation is accompanied by a rapid decrease in the volatility of O/N PRIBOR deviations from the repo rate. A decrease in the variability of the spread between both interest rates is reflected in an increase in the serial autocorrelation of the spread between O/N PRIBOR and the repo rate. The negative skewness of the frequency distribution is reduced only slightly while there is a larger decrease in its kurtosis.

Figure 5a and 5b: Relative Frequencies of the Spread between O/N PRIBOR and the Repo Rate (Interval Size = 5 bps)

a) 1. 1. 1998 - 2. 8. 1999



b) 3. 8. 1999 - 30. 6. 2004



One of the causes of a decrease in the average spread between O/N PRIBOR and the repo rate may have been more intense speculation by banks for a decrease in the repo rate in 1998-1999. These decreases may not always have been realized due to CNB's somewhat hesitant attitude. On the other hand, a steep reduction in volatility of the spread between both interest rates can be explained by noting that the amount of unsatisfied orders by banks to create a deposit with CNB are not identical for each bank. Excess reserves are accumulated in the largest banks while smaller banks or branches of foreign banks suffer from the lack of reserves. Therefore, the use of intraday credit significantly weakened the overall demand for, and instability of, liquidity.

Table 4: Main Characteristics of the Spread between O/N PRIBOR and the Repo Rate

	1.1.1998-2.8.1999	3.8.1999-30.6.2004
Mean	-0.233	-0.027
Standard errors	1.490	0.154
Skewness	-4.192	-3.131
Kurtosis	23.212	14.854
Minimum	-11.150	-0.910
Maximum	4.120	0.690

Experiments with estimations of the regression parameters of equation (10) confirm that variations in the spread between O/N PRIBOR and the repo rate behave in a different way before and after the introduction of intraday credit.

a) 1. 1. 1998 - 2. 8. 1999

$$\Delta(IR_t^{O/N} - REPO_t^s) = -0{,}319\Delta(IR_{t-1}^{O/N} - REPO_{t-1}^s) - 0{,}419\Delta(IR_{t-2}^{O/N} - REPO_{t-2}^s) - 0{,}212\Delta(IR_{t-3}^{O/N} - REPO_{t-3}^s) - 0{,}153\Delta(IR_{t-4}^{O/N} - REPO_{t-4}^s) - 0{,}038(R_t^S - R_t^D) + 0{,}44D^1 - 0{,}432D^{10}$$

b) 3. 8. 1999 - 30. 6. 2004

$$\Delta(IR_t^{O/N} - REPO_t^s) = -0{,}803\Delta(IR_{t-1}^{O/N} - REPO_{t-1}^s) - 0{,}763\Delta(IR_{t-2}^{O/N} - REPO_{t-2}^s) - 0{,}645\Delta(IR_{t-3}^{O/N} - REPO_{t-3}^s) - 0{,}615\Delta(IR_{t-4}^{O/N} - REPO_{t-4}^s) - 0{,}525\Delta(IR_{t-5}^{O/N} - REPO_{t-5}^s) - 0{,}392\Delta(IR_{t-6}^{O/N} - REPO_{t-6}^s) - 0{,}248\Delta(IR_{t-7}^{O/N} - REPO_{t-7}^s) - 0{,}147\Delta(IR_{t-8}^{O/N} - REPO_{t-8}^s) - 0{,}001(R_t^S - R_t^D)$$

In the period before intraday credit was introduced, actual variations in the spread were influenced not only by serial autocorrelation but also by errors of excess liquidity prediction and calendar effects. These calendar effects at the beginning and end of the maintenance period were very important. The parameters of the autoregression process and liquidity prediction errors are statistically significant at the 1% significance level while the parameters of calendar effects are statistically significant at the 5% level. The model explains 25% of variability in the spread of both interest rates.

The addition of intraday credit resulted in a marked weakening of the influence of liquidity prediction errors on movements of the spread between O/N interest rates and the repo rate, and simultaneously removed systematic calendar effects. Therefore, variations in the spread between both interest rates should be explained by the 8th-degree autoregression correlation and only minimally by the influence of liquidity prediction errors. All parameters are statistically significant at the 1% significance level and the model explains 42% of the spread variability.

The high degree of autoregression is apparently a consequence of lowering spread volatility between O/N PRIBOR and the repo rate. It is somewhat surprising that the increase in volatility of liquidity prediction errors in 2001-2004 did not result in a deviation of O/N PRIBOR from the proximity of the repo rate. This result may stem from banks having a sufficient volume of these securities to secure intraday credit. Recall that a high portion of public debt is financed by Treasury Bills. Therefore, banks may not have to buy these resources in the interbank market.

Opposite signs in regression parameters of liquidity prediction errors and calendar effects confirm that CNB has better information on the daily need for liquidity in the interbank market than banks themselves. This information stems from variations in state budget flows that are hard to predict. It is evident from the CNB's systematic underestimation of the supply of excess reserves that higher volatility of liquidity prediction errors do not increase the volume of excess liquidity in the market and do not influence the movements of O/N interest rates. Reverse parameter signs for the first and last day of the maintenance period are explained by an overall excess of liquidity in the home interbank market. Banks can satisfy minimum reserve requirements from their own sources and need not borrow for their creation from CNB. The efforts of banks to valorize the excess of reserves in the interbank market at the last day of the maintenance period may play a role.

CONCLUSION

The monetary policy of stabilizing ultra-short interest rates in the proximity of the repo rate is the basic prerequisite to achieve set monetary targets. Perfect management of ultra-short interest rates assumes that the volatility of O/N interest rates do not exceed the announced level of the repo rate by a large margin. The volume of liquidity in the money market is in line with the needs of banks. That is, the supply of liquidity by the central banks mirrors the demand of banks for reserve resources through open market operations.

The study of basic theoretical approaches of ultra-short interest rate determination shows elements of a changing demand for reserves. These changes in bank demand for reserves occurred mainly in the context of intertemporal substitution of reserves. This paper demonstrates that the development of reserve demand was fundamentally different when the central bank ensured the stability of ultra-short interest rates through targeting of market interest rate than when it targeted the effective repo rate through open market operations.

The empirical analysis of the behavior of O/N PRIBOR explicitly demonstrates CNB's ability to stabilize O/N interest rates in near proximity of the repo rate. It also identified some structural changes in the money market. First, introduction of intraday credit significantly reduced instability of the demand for reserve resources in the interbank market and decreased the volatility of ultra-short interest rates. We also document a relatively rapid increase in the volatility of liquidity prediction errors on CNB's part in the 2001-2004 period and underestimation of the general concern of banks in the deposition of excess liquidity with CNB. This underestimation resulted in weakening the direct relationship between O/N PRIBOR and the success of the repo tenders carried out by CNB.

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NARROW PRICE LIMIT AND STOCK PRICE VOLATILITY IN EMERGING MARKETS: EMPIRICAL EVIDENCE FROM AMMAN STOCK EXCHANGE

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ABSTRACT

This paper empirically investigates the behaviour of daily stock return volatility around price limit hits for a sample of 159 (189) securities listed in Amman Stock Exchange (ASE), over the years 2003(2004). More specifically, we investigate whether daily return volatility for stocks that hit a price limit is lower (higher) in the post limit hit period than in the pre limit hit period. Such a finding would be consistent with the overreaction hypothesis, also referred to as the volatility spill over hypothesis. Our results indicate that stocks-hit experience their highest level of volatility on the day when stocks-hit reach their upper daily price limits of 5% (day 0), and decreases significantly one day after the hit. Similar results are found when stock hits reach their lower daily price limits of -5%, however with less magnitude. Results on the different sectors reveal that the banking sector experiences the highest volatility. However, when the stocks-hit reach its lower limit, the service sector shows the highest volatility as compared to the other sectors in the industry. Therefore, our results are more consistent with the overreaction hypothesis and that the price-limit technique is effective in reducing the volatility by providing a time-out to cool-off.

INTRODUCTION

Learning from the experience of stock market crashes, especially the Kuwaiti stock market (Al-Manakh) crash in 1982, and the black Monday stock crisis in October 1987 in the USA, the Amman Stock Exchange (ASE), like many other exchanges established a narrow limit on daily price movement to control volatility.

This paper empirically investigates the behaviour of daily stock return volatility around price limit hits for a sample of 159 (189) securities listed in ASE for the years 2004 (2005). Price limits set by the market establish literal boundaries where security prices are allowed to move within a trading day, thereby, provide a *cooling off* period. However, since price limits prevent one-day large price changes from occurring, they may cause price adjustments to spread out over a longer period of time. The absence of high liquidity in ASE may worsen information uncertainty and cause an increase in return volatility after the limit hit period when trading starts the next day. Therefore, daily return volatility for stocks that hit a price limit is expected to be lower (higher) in the post limit hit period than in the pre limit hit period according to the overreaction hypothesis (*volatility spill over hypothesis*).

This paper provides insight into stock market dynamics and systematic weaknesses, which will subsequently help us suggest certain reforms. It contends that price limits might not have the same effect across exchanges due to the marked differences in both market architecture and institutional characteristics. Markets can be organized as periodic call auctions, continuous auctions, or as continuous dealer markets. Most of the literature focuses on markets where trading takes place continuously or the market clears frequently during operating hours. This study, however, investigates the issue in a market characterized by thin trading, low liquidity, and the non-existence of different trading instruments and mechanisms.

The main restrictions of the daily price limit and short-selling limits, used to dampen volatility that affect small investors, might have major implications on stock prices. Such implications include, producing high correlation between stock prices, making future prices predictable, reducing the efficiency of the market and hindering the formation of efficient portfolios. Since price limits directly interfere with asset price resolution, their impact on volatility and consequently on returns have recently attracted special interest from policy makers, investors, practitioners and academic researchers in the emerging market of Jordan. In order to protect the stock exchanges, authorities must make informed decisions. These decisions cannot be worthwhile unless they are based on serious studies. Therefore, the issue of price limit is very important and worth studying.

The ASE has many features that make the study of price limit important. First, trading in ASE does not rely on dealers or market makers. Therefore, market liquidity is limited by the amount of securities supplied and demanded by traders who submit their market or limit orders. The second feature of ASE, as is the case in many emerging exchanges, is the implementation of a price limit. Contrary to other exchanges, since 1992 ASE has been regulated by narrow daily price change limits of +/-5% on individual securities as. The regulatory purpose of setting up this price limit was to dampen speculative overreactions of stock prices hoping to protect small investors. The third feature of ASE is the lack of trading instruments such as short-selling and the non existence of derivative securities as well as the restrictions of some trading mechanisms, such as trading on margin, which is limited to some stocks and restricted to some brokers and customers.

Although few research papers in the literature investigate the issue of price limits and circuit breakers, no unanimity is being reached as to the usefulness of price limits in reducing the volatility of stock markets. Proponents of price limit rules believe in its importance in managing settlement risk since it helps avoid defaults by brokers and their clients by limiting the size of intra-day losses and margin calls. Moreover, price limits are related to the objective of providing and facilitating the restoration of orderly trading (*cooling off effect*) and allows traders in the market some time to evaluate information and think rationally with less emotion during times of panic trading (*time-out period*). It helps dampen the overreaction in the stock markets and decreases the risk that investors bear during turbulent trading days. Therefore, price limit mechanisms are supposed to ensure smooth prices. Finally, limits help retain confidence of small investors who may stay away from the market due to large swings in stock prices, and it makes the job for manipulators and insider traders more difficult to take advantage of other investors.

The opponents of price limit, however, argue that limits usually are associated with certain costs to traders. Price limit interferes with liquidity and price discovery and accelerates movements toward the limits (*i.e. magnet effect hypothesis*). Critics also claim that price limit causes higher volatility levels on subsequent days (*i.e. spill over hypothesis*), and interferes with trading due to limitations imposed by these limits (i.e. *trading interference hypothesis*). It is particularly harmful to trading in relatively illiquid stocks, however, these carry no significant outstanding positions that could cause settlement risk, and hinders the introduction of new derivative products.

INSTITUTIONAL BACKGROUND OF ASE

A daily price change limit of 10% was first introduced in ASE during the 1980s, but it was reduced to 2% during the Gulf War in 1991. However, since 1992, the price limit is set at 5%, similar to that of the Austria and Turkey stock exchanges.

The trading system in ASE is similar to limit order market systems used in other exchanges. Specifically, it implements the French program (GL) of trading screens. This system is used by both brokers and trading monitors each according to his/her purposes. Trading in ASE takes place from Sunday to Thursday and closes on Fridays, Saturdays and on public holidays. Each trading day orders are entered 30 minutes prior to the market open at 9:30 am local time, which is followed by a continuous trading cession after the opening auction from 10 to 12 pm. There is one trading session (10 am to 12 pm). During the pre-opening phase the brokers enter the market and limit orders. At the opening phase, the entered orders are executed if the orders are within the permitted limits of the price change (± 5%) from the last closing price.

In this market, trading is permitted only at prices within limits determined by the reference price of the previous day. If the security price moves outside the equilibrium price, trading in the market ceases until either the price moves back to equilibrium or until the next day when the new limit is set based on the reference price of the current day. The reference price is usually equivalent to the closing price of the previous day. When the security is not traded, for a few days, however, an upper limit of 5% daily is added to the last closing price which forms the reference price. Therefore, a large move in the underlying equilibrium price may cause the price to move the limit on several successive days with no trading taking place.

The source of liquidity in ASE is the limit orders in the order book, provided by both investors and brokers, since there are no floor traders, market makers or specialists with special quoting obligations or trading privileges. Investors place orders in the order book through brokers who are connected directly to the electronic trading system. The brokers can trade on their own accounts, as well as, on behalf of outside investors. This choice of trading might be determined by the profitability of supplying liquidity in different market conditions or in different stocks.

LITERATURE REVIEW

The literature on the effect of price limits indicate that price limits are mainly implemented by smaller, emerging and less developed exchanges. The smaller and less developed the exchange is, the narrower the price limits used, mainly because of the lack of suitable risk management system and the lack of liquidity. The more developed the exchange is, however, the wider the price limit implemented, and is used sometimes in addition to circuit breakers, or sometimes, according to their needs, as the only circuit breakers.

The effect of price limits on stock exchanges is inconclusive, while many studies show a positive effect of price limits (see Kodres and O'Brien (1994), Hopewell and Schwartz (1978), Ma et. al (1989), Ma *et al.* (1990), and Huang *et al.* (2001), other studies (Lee, Ready, and Seguin (1994),Gay *et al.* (1994), Kim and Rhee (1997), Chen (1998), Cho *et al.* (2003), and Chan *et al.* (2005)) have challenged the expected advantage of price limits.

Kodres and O'Brien (1994), for example, examine the effect of price limits, and find that price limits may promote better risk sharing than unconstrained trading when price fluctuations are driven by news about fundamentals. In their seminal work, Hopewell and Schwartz (1978) notice large abnormal price adjustments over the suspension period, and an anticipatory behavior of stock returns prior to the suspension. According to the authors, this behaviour is consistent with a quick adjustment to new equilibrium. Ma, Rao and Sears (1989) find that after a price limit hit, prices tend to stabilize or reverse. They also find a decline in return volatility and more stability in volume traded. Lee and Kim (1995) investigate the data of the Korea Stock Exchange and find that price limits reduce stock price volatility.

Other research studies challenge the usefulness of price limits. The literature documents three main issues related to the problems associated with price limits, volatility spillover, the delay in price discovery and the trading interference hypotheses (see for example, Lee, Ready, and Seguin (1994) Kim and Rhee 1997, and Bidlik and Gulay 2003 among others).

Lee, Ready, and Seguin (1994) find that trading halts at the NYSE do not reduce either volume nor price volatility, but merely interfere with the normal trading activity and making delay in price discovery. They show a higher level of both volume and volatility on the period followed immediately the trading halt. Therefore, price limits prevent the stock from reaching to its equilibrium price at a single trading day and have to wait until the next trading day to continue toward the new true (i. e. equilibrium) price. This is consistent with the delay in price discovery. Kim and Rhee (1997), conclude that price limits used on the Tokyo Stock Exchange might be ineffective.

The other effect of price limits found in the literature is the "*magnet effect*". Arak and Cook (1997); Cho *et al.* (2003), among others, discuss this magnet effect of price limits. In this effect security prices tend to accelerate toward the bounds. This effect could be due to a fear of market illiquidity (Subrahmanyam (1994), and the behaviour of market participants (Arak and Cook (1997)). In a recent study on Taiwan Stock Exchange Cho *et al.* (2003), find a clear effect in the movement of securities toward the upper limit, while weak evidence if found of acceleration toward the lower limit as prices reach the bound. Chan *et al.* (2005) using data from Kuala Lumpur stock Exchange find that price limit could cause order imbalances prior to the limit hit.

This paper extends the literature by giving an evidence of the effect of narrow price limit on stock market volatility, a market which is characterized by thin trading, lack of liquidity and the lack of different trading instruments.

DATA DESCRIPTION

For the purpose of testing the research hypotheses, we use daily prices for 159 companies in 2003 and 189 companies in 2004 listed in ASE in both the first and second markets between January 1, 2003 and December 31, 2004. These companies represent all the four sectors classified according to ASE. These sectors are banks, insurance, services and manufacturing. Table (1) shows summary statistics for our data. The table shows 466 trading days during the period 1/1/2003-12/31/2004, with an average daily return for all sectors/markets of 0.18%. The banking sector experience the highest return, and the insurance and industry sectors have the lowest returns 0.12%. There are 242 (224) trading days in 2003 (2004), with an average daily return of 0.20% (0.20%), and the banking sector experiences the best return during both sub periods, while the insurance (industry) sector experiences the lowest return in 2003 (2004).

METHODOLOGY

This paper follows a similar methodology adopted by Kim and Rhee (1997). First, we identify the days where the high (low) price matches its previous day's closing price plus (minus) the price limit. Then we measure the price volatility around the days, when the price hits the limit.

In order to identify those days when prices hit the limit, we assume that the upper price limits are reached for a specific stock when $Ht \geq Pt\text{-}1 + LIMITt$. Where Ht represents the high price on day t, Pt-1 represents the previous day's closing price and LIMITt is the 5% maximum allowable upward price movement for each day t. Likewise, we assume that the lower price limits are reached for a specific stock when $Lt \leq Pt\text{-}1 - LIMITt$. Where Lt represents the low price on day t, Pt-1 represents the previous day's closing price and LIMITt is the 5% maximum downward price movement for each day t. For this purpose, we compute the close-to-close changes using day t-1 closing price and day t closing price for stock j using the following equation:

$$R_{jt} = \frac{P_{jt} - P_{jt-1}}{P_{jt-1}} \qquad (1)$$

R_{jt} is daily movement of the stock j on day t.
P_{jt} is the closing price of stock j on day t.
P_{jt-1} is the closing price of stock j on day t.

In addition, on days when price limits are reached, we classify stocks that did not reach the price-limit into six subgroups. Stocks that having price movements, up or down, in the ranges of 4.90% - 4.99%, 4.80% - 4.89%, 4.70% - 4.79%, 4.60% - 4.69% and 4.50% - 4.59%. That is within at least 90% of reaching the daily limit, and those stocks whose price movements are less than 90% of reaching the daily limit. These Stocks are referred to as Stock4.90%, Stock4.80%, Stock4.70%, Stock4.60% and Stock4.50%, respectively. The subscripts denote the magnitude of a stock's price change on Day 0, the limit-hit-day. Stock hit refer to those stocks which hit their daily price limit.

Table (1) reports the number of price-limit-hit occurrences, as well as the number of occurrences for each of the other five categories, outlined above, for both upper and lower price movements for each sector in each market, as well as the aggregate results, during the period 1/1/2003 - 31/12/2004.

It can be seen from panel C in table 1 that there are 1033 price-limit hits, of which 603 occur when upper daily price-limits are hit and 430 occurrences when lower price-limits are hit, i.e. Stock hit. These numbers indicate that ASE price-limits prevents more stock price increases than decreases. This preliminary conclusion is, in fact, consistent with that of Tokyo Stock Exchange (TSE) (Kim and Rhee, 1997, p. 890) and Istanbul Stock Exchange (ISE) (Bildik and Gulay, 2003, p. 9). In addition, the table shows that such conclusion is valid for each sector in each market. Also, the same has been found in a year-by-year analysis. The results, as reported in panel A and panel B, reveal that in 2003 (2004) there were 392 (211) occurrences of upper daily price-limit hits and 290 (140) occurrences of lower daily price-limit hits.

Similarly, there are 2258 (782) occurrences when daily price movements approached but did not reach the upper (lower) price-limit, i.e. Stock4.90%, Stock4.80%, Stock4.70%, Stock4.60% and Stock4.50% , during the period 1/1/2003-31/12/2004. There are 1095 (376) occurrences when the price approached but did not reach the upper (lower) price-limit in 2003 and 1163 (406) in 2004 respectively.

To test the volatility spill over hypothesis, we measure daily price volatility by the following equation:

$$V_{jt} = (R_{jt})^2 \qquad (2)$$

Where:
V_{jt} is the daily price volatility for stock j on day t.
R_{jt} is the daily return on stock j on day t.

We apply a 21-day event window. That is from Day -10 to Day +10, where Day 0 represents the event-day, that is the limit-hit-day, Day -1 represents one day before the event day and Day +1 represents one day after the event day, and so forth. Also, the same event window is applied to a control group of stocks that experienced a maximum (minimum) of +4% (-4%) daily price movements, but did not reach the upper (lower) price limit hit +5% (-5%). This control group is used as a benchmark for the volatility of price limit hits during post-limit days. The second successive same price limit hits are excluded in order to eliminate the high price limit-day volatility bias that occurs when these consecutive hits are considered independent events. Hence, the sample size for upper price limit hit events (+5%) for all sectors are reduced from 603 to 556, whereas the sample size for the control sample (+4%) is 1729. Additionally, the lower price limit hit events (-5%) for all sectors is reduced from 430 to 368, whereas the sample size for the control sample (-4%) is 689.

Table 1: Summary Statistics

Panel A: presents the sample size of each of these six categories during the study period 1/1/2003 to 31/12/2003 for both upward and downward price movements.

Stock Category	**Bank Sector**			**Insurance Sector**			**Service Sector**			**Industry Sector**			**Total Sectors**		
	M1	M2	M1+M2	M1	M2	M1+M2	M1	M2	M1+M2	M1	M2	M1+M2	M1	M2	M1+M2
Downward Price Movements															
-5.0%	120	1	121	8	6	14	18	24	42	12	101	113	158	132	290
-4.9%	2	0	2	6	4	10	24	7	31	20	10	30	52	21	73
-4.8%	12	0	12	10	2	12	10	18	28	21	10	31	53	30	83
-4.7%	8	1	9	5	8	13	18	13	31	21	22	43	52	44	96
-4.6%	4	0	4	3	4	7	7	15	22	11	14	25	25	33	58
-4.5%	9	1	10	2	8	10	6	10	16	19	11	30	36	30	66
SubTotal	***155***	***3***	***158***	***34***	***32***	***66***	***83***	***87***	***170***	***104***	***168***	***272***	***376***	***290***	***666***
Upward Price Movements															
4.5%	10	2	12	7	15	22	21	35	56	40	57	97	78	109	187
4.6%	18	2	20	11	16	27	31	34	65	51	35	86	111	87	198
4.7%	43	4	47	18	15	33	40	36	76	59	46	105	160	101	261
4.8%	30	1	31	15	10	25	35	36	71	59	35	94	139	82	221
4.9%	33	3	36	7	10	17	48	28	76	66	33	99	154	74	228
5.0%	128	3	131	14	9	23	32	49	81	34	123	157	208	184	392
SubTotal	262	15	277	72	75	147	207	218	425	309	329	638	850	637	1487
Downdward and Upward Price Movements															
Grand Total	**417**	**18**	**435**	**106**	**107**	**213**	**290**	**305**	**595**	**413**	**497**	**910**	**1226**	**927**	**2153**
No. of Co's	**15**	**1**	**16**	**11**	**14**	**25**	**19**	**27**	**46**	**34**	**38**	**72**	**79**	**80**	**159**
Average Daily Returns (242 days)			0.30%			0.13%			0.20%			0.18%			0.20%

Panel B: presents the sample size of each of the six categories during the study period 1/1/2004 to 31/12/2004 for both upward and downward price movements.

Stock Category	Bank Sector			Insurance Sector			Service Sector			Industry Sector			Total Sectors		
	M1	M2	**M1+M2**	M1	M2	**M1+M2**	M1	M2	**M1+M2**	M1	M2	**M1+M2**	M1	M2	**M1+M2**
Downdward Price Movements															
-5.0%	12	7	19	6	13	19	27	18	45	27	30	57	72	68	**140**
-4.9%	6	0	6	4	6	10	22	12	34	12	8	20	44	26	70
-4.8%	4	2	6	4	6	10	18	15	33	17	20	37	43	43	86
-4.7%	8	1	9	6	4	10	23	11	34	13	23	36	50	39	89
-4.6%	4	1	5	7	9	16	15	21	36	16	14	30	42	45	87
-4.50%	2	1	3	5	5	10	8	14	22	16	23	39	31	43	74
SubTotal	***36***	***12***	***48***	***32***	***43***	***75***	***113***	***91***	***204***	***101***	***118***	***219***	***282***	***264***	***546***
Upward Price Movements															
4.5%	9	8	17	5	20	25	33	28	61	25	28	53	72	84	156
4.6%	17	4	21	14	19	33	49	42	91	44	39	83	124	104	228
4.7%	14	8	22	19	21	40	54	36	90	49	44	93	136	109	245
4.8%	36	5	41	14	14	28	65	22	87	92	37	129	207	78	285
4.9%	54	3	57	7	17	24	56	24	80	67	21	88	184	65	249
5.0%	15	8	23	11	21	32	36	54	90	30	36	66	92	119	**211**
SubTotal	***145***	***36***	***181***	***70***	***112***	***182***	***293***	***206***	***499***	***307***	***205***	***512***	***815***	***559***	***1374***
Downdward and Upward Price Movements															
Grand Total	**181**	**48**	**229**	**102**	**155**	**257**	**406**	**297**	**703**	**408**	**323**	**731**	**1097**	**823**	**1920**
No. of Co's	**13**	**3**	**16**	**10**	**16**	**26**	**26**	**35**	**61**	**35**	**51**	**86**	**84**	**105**	**189**
Average Daily Returns (224 days)			0.30%			0.11%			0.13%			0.08%			0.20%

Panel C: presents the sample size of each of the six categories during the study period 1/1/2003 to 31/12/2004 for both upward and downward price movements.

Stock Category	Bank Sector			Insurance Sector			Service Sector			Industry Sector			Total Sectors		
	M1	M2	**M1+M2**	M1	M2	**M1+M2**	M1	M2	**M1+M2**	M1	M2	**M1+M2**	M1	M2	**M1+M2**
Downdward Price Movements															
-5.0%	132	8	140	14	19	33	45	42	87	39	131	170	230	200	430
-4.9%	8	0	8	10	10	20	46	19	65	32	18	50	96	47	143
-4.8%	16	2	18	14	8	22	28	33	61	38	30	68	96	73	169
-4.7%	16	2	18	11	12	23	41	24	65	34	45	79	102	83	185
-4.6%	8	1	9	10	13	23	22	36	58	27	28	55	67	78	145
-4.5%	11	2	13	7	13	20	14	24	38	35	34	69	67	73	140
SubTotal	*191*	*15*	*206*	*66*	*75*	*141*	*196*	*178*	*374*	*205*	*286*	*491*	*658*	*554*	*1212*
Upward Price Movements															
4.5%	19	10	29	12	35	47	54	63	117	65	85	150	150	193	343
4.6%	35	6	41	25	35	60	80	76	156	95	74	169	235	191	426
4.7%	57	12	69	37	36	73	94	72	166	108	90	198	296	210	506
4.8%	66	6	72	29	24	53	100	58	158	151	72	223	346	160	506
4.9%	87	6	93	14	27	41	104	52	156	133	54	187	338	139	477
5.0%	143	11	154	25	30	55	68	103	171	64	159	223	300	303	603
SubTotal	***407***	***51***	***458***	***142***	***187***	***329***	***500***	***424***	***924***	***616***	***534***	***1150***	***1665***	***1196***	***2861***
Downdward and Upward Price Movements															
Grand Total	**598**	**66**	**664**	**208**	**262**	**470**	**696**	**602**	**1298**	**821**	**820**	**1641**	**2323**	**1750**	**4073**
No. of Co's	**28**	**4**	**32**	**21**	**30**	**51**	**45**	**62**	**107**	**69**	**89**	**158**	**163**	**185**	**348**
Average Daily Returns (466 days)			0.34%			0.12%			0.14%			0.12%			0.18%

Panel 3, Note 1: M1 refers to the First Market and M2 refers to the Second Market.
Note 2: Stocks are categorized into six groups based on the level of their price movements on Day 0 (the event day). Stocks 5% denote stocks that reach their daily price limit up (+) or down (-). Where limit refers to the maximum allowable daily price movement on Day t. Stocks 4.9% denote stocks that experience a price change of 4.9% from

the previous day's close, but do not reach a price limit. Stocks 4.8% denote stocks that experience a price change of 4.8% from the previous day's close, but do not reach a price limit. And so forth up to a price change of 4.5% from the previous day's close. Each number in the table represents the number of hits for each of these six levels of price changes for each sector in each market.

The volatility measure is computed for each stock. We compute averages for each day within the event window. A finding that price-limit-hit stocks experience greater volatility during post limit days than those that experience no hits supports the volatility spill over hypothesis. In addition, we computed the t-statistics of the Wilcoxon signed-rank test for volatility differences between the price-limit-hit group and that of the control group. Here we assume that the sample distribution of the differences in matched pairs is symmetric and we test the null hypothesis that the distribution is centred on zero difference. Discarding pairs for which the difference is zero, we rank the remaining absolute differences in ascending order. The sums of the ranks are calculated and the smaller of these sums is the Wilcoxon test statistic. The null hypothesis is rejected if the t-statistic is less than or equal to the value of the cumulative distribution function of the standard normal distribution (Newbold (1991), p. 421). The t-statistic is calculated as the difference between the control sample and the price-limit-hit sample, divided by the standard error, as follows (Hair *et al.* (1998), p. 360):

$$t-statistic=\frac{Mean_{\text{Control Sample}}-Mean_{\text{Price-Limit-Hit Sample}}}{\sqrt{\dfrac{VAR_{\text{Control Sample}}}{SampleSize_{\text{Control Sample}}}+\dfrac{VAR_{\text{Price-Limit-Hit Sample}}}{SampleSize_{\text{Price-Limit-Hit Sample}}}}} \quad (3)$$

The model above is calculated for the upper and the lower price-limit-hits.

RESULTS ON UPPER LIMIT HITS

Table (2) outlines the volatility in daily returns around upper price limit hits of +5%, as well as around the benchmark of price movement of +4%, for each sector as well as for the overall market. Also, the table reports the t-statistics according to Wilcoxon signed-rank test.

As we expected, stocks-hit experience their highest level of volatility on the day when stock-hits reached their upper daily price limits (day 0). Clearly, it can be seen from the table that the volatility of stocks-hit increased from 0.20% on day -10 to 0.31% on day -5 and jump to 5.03% on day 0, then decreased significantly to 0.18% on Day +1 and fluctuate down-ward significantly up to day +10 when it reached lowest volatility of 0.15%. Panel (A) in figure (1) shows the behavior of this volatility.

Although similar behavior can be seen in each sector, the table reveals that the banking sector has the highest volatility, followed by the manufacturing sector and the service sector, and finally, the insurance sector. Also, the volatility of the banking sector during post-limit hit days are the most significant in comparison to the control group. Similar patterns can be seen in the manufacturing sector. However, none of the post-limit day's volatility in the insurance and the service sectors is significant. Panels (B), (C), (D), and (E) in figure (1) show the behavior of the volatility in the banking, insurance, services and industry sectors, respectively.

Table 2: Volatility in the Daily Returns around Upper Limit Price Hits

	ALL SECTORS			BANKS			INSURANCE		
Days	**PLH +5%**	**+4%**	**T-Value**	**PLH +5%**	**+4%**	**T-Value**	**PLH +5%**	**+4%**	**T-Value**
-10	**0.20%**	0.07%	-0.9578	**0.47%**	0.07%	-1.0764	**0.01%**	0.05%	0.4030
-9	**0.21%**	0.08%	-0.5357	**0.48%**	0.06%	-2.5351**	**0.03%**	0.03%	0.0826
-8	**0.25%**	0.23%	-0.0163	**0.67%**	0.05%	-2.1129**	**0.01%**	0.04%	0.2564
-7	**0.24%**	0.06%	-1.3953	**0.33%**	0.05%	-4.0862**	**0.07%**	0.04%	-0.4988
-6	**0.27%**	0.06%	-1.9517**	**0.80%**	0.04%	-2.4778**	**0.03%**	0.04%	0.1979
-5	**0.31%**	0.10%	-0.6086	**0.91%**	0.05%	-2.3694**	**0.05%**	0.05%	-0.0222
-4	**0.32%**	0.12%	-0.3629	**0.47%**	0.05%	-2.7667**	**0.08%**	0.04%	-0.4933
-3	**0.41%**	0.06%	-1.9871**	**0.51%**	0.05%	-3.3456**	**0.08%**	0.04%	-0.7506
-2	**0.34%**	0.10%	-1.0356	**0.33%**	0.05%	-3.8043**	**0.06%**	0.06%	0.0121
-1	**0.20%**	0.15%	-0.1323	**0.30%**	0.08%	-1.8109**	**0.05%**	0.07%	0.1913
t0	**5.03%**	0.23%	-2.3149**	**10.58%**	0.23%	-1.1346	**3.22%**	0.23%	-1.7661**
+1	**0.18%**	0.13%	-0.1531	**0.32%**	0.09%	-3.097**	**0.10%**	0.08%	-0.3817
+2	**0.16%**	0.12%	-0.1013	**0.25%**	0.09%	-1.3886	**0.07%**	0.08%	0.1159
+3	**0.18%**	0.07%	-2.0972**	**0.31%**	0.10%	-0.7906	**0.07%**	0.06%	-0.2600
+4	**0.22%**	0.06%	-3.0167**	**0.43%**	0.06%	-2.3784**	**0.08%**	0.05%	-0.2715
+5	**0.23%**	0.07%	-1.8741**	**0.44%**	0.08%	-1.3730	**0.05%**	0.05%	0.0298
+6	**0.23%**	0.06%	-1.6883	**0.62%**	0.05%	-1.9921**	**0.06%**	0.04%	-0.2819
+7	**0.19%**	0.05%	-3.3263**	**0.40%**	0.06%	-2.0512**	**0.07%**	0.04%	-0.4378
+8	**0.25%**	0.05%	-2.2158**	**0.38%**	0.05%	-2.7759**	**0.06%**	0.03%	-0.6246
+9	**0.21%**	0.06%	-3.5854**	**0.31%**	0.06%	-2.8170**	**0.04%**	0.05%	0.1082
+10	**0.15%**	0.05%	-1.9534**	**0.39%**	0.05%	-2.2352**	**0.05%**	0.04%	-0.0920

	SERVICES			INDUSTRY		
Days	**PLH +5%**	**+4%**	**T-Value**	**PLH +5%**	**+4%**	**T-Value**
-10	**0.06%**	0.08%	0.0987	**0.21%**	0.07%	-0.5568
-9	**0.13%**	0.15%	0.0347	**0.16%**	0.05%	-2.2278**
-8	**0.13%**	0.48%	0.0835	**0.17%**	0.13%	-0.0457
-7	**0.29%**	0.06%	-1.0154	**0.20%**	0.08%	-0.4538
-6	**0.11%**	0.10%	-0.0471	**0.16%**	0.05%	-1.2032
-5	**0.13%**	0.10%	-0.1601	**0.19%**	0.14%	-0.0572
-4	**0.29%**	0.09%	-0.6448	**0.32%**	0.19%	-0.1004
-3	**0.11%**	0.08%	-0.4997	**0.68%**	0.06%	-1.3702
-2	**0.39%**	0.09%	-1.3536	**0.38%**	0.13%	-0.4508
-1	**0.30%**	0.22%	-0.1209	**0.11%**	0.15%	0.0505
t0	**3.26%**	0.23%	-1.7607**	**3.84%**	0.23%	-2.6959**
+1	**0.12%**	0.10%	-0.3627	**0.18%**	0.18%	-0.0077
+2	**0.11%**	0.09%	-0.3450	**0.16%**	0.16%	0.0003
+3	**0.13%**	0.08%	-0.6266	**0.17%**	0.06%	-2.0120**
+4	**0.16%**	0.07%	-0.9086	**0.18%**	0.06%	-2.0100**
+5	**0.13%**	0.07%	-1.0671	**0.23%**	0.07%	-0.8838
+6	**0.09%**	0.09%	0.0058	**0.15%**	0.05%	-2.1364**
+7	**0.09%**	0.06%	-0.8994	**0.19%**	0.05%	-2.4988**
+8	**0.37%**	0.07%	-1.1437	**0.12%**	0.05%	-1.7501**
+9	**0.12%**	0.06%	-1.2756	**0.27%**	0.05%	-2.2687**
+10	**0.08%**	0.07%	-0.0835	**0.09%**	0.04%	-1.4468

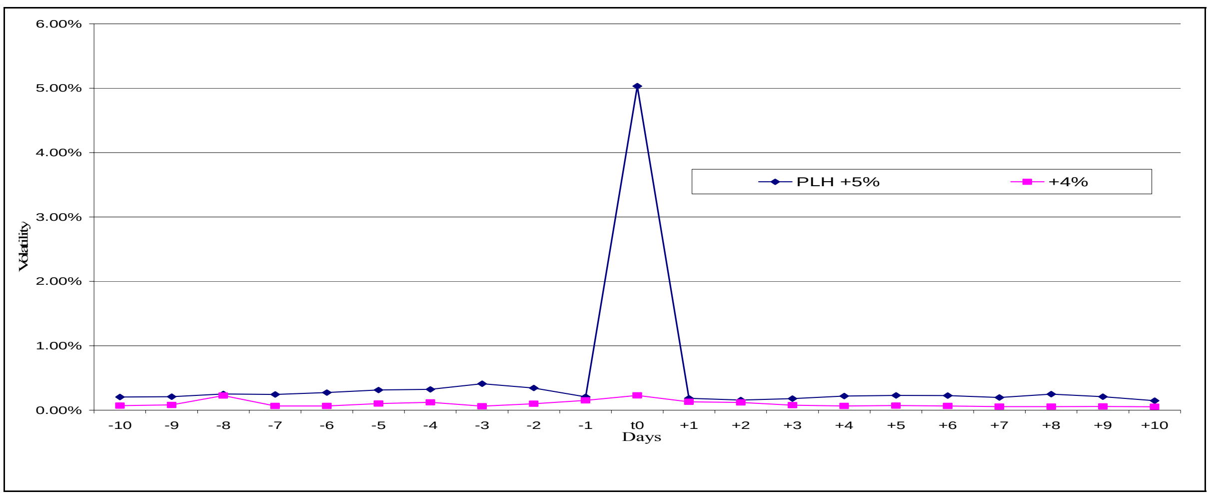
Note: Stocks are categorized into two groups (+5% and +4%) based on the level of their price movements on Day 0. Stocks 5% denote stocks that reach their upper daily price limit (+). Limit refers to the maximum allowable daily price movement on Day t. The main categories are presented for upward price movements. Each number (in %) in the table represents the volatility of daily returns at and around price limit hit for each sector during the period 1/1/2003 to 31/12/2004. T-value is computed according to Wilcoxon signed-rank test.

In fact, movements in the daily returns volatility started on day -6, at which the difference from the control group is significant. But eased afterward until day -3, when it almost doubled, then halted until the price limit hit day. The volatility relaxed significantly during the post-limit hit days. This behavior has led many researchers, such as Ma *et al.* (1989), to conclude that price limit is an effective tool in reducing volatility of the stock exchange.

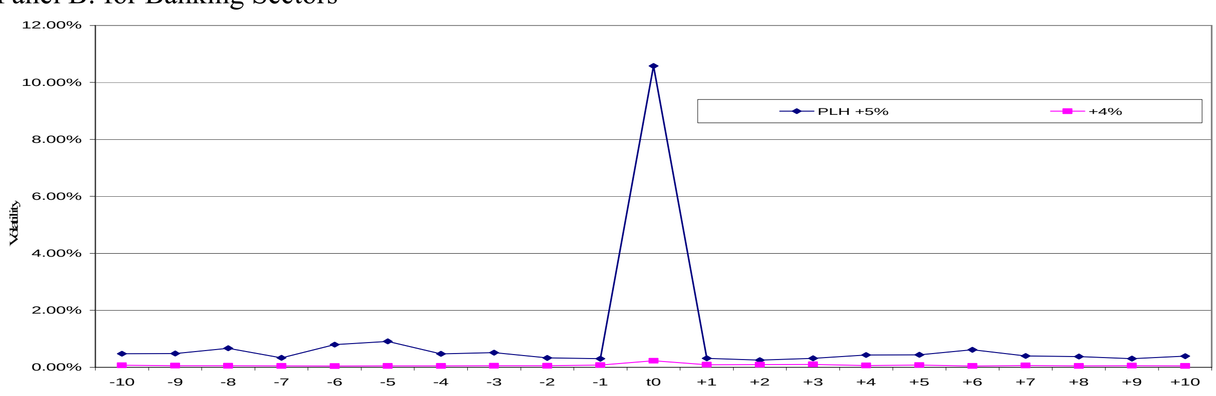
However, there are two arguments, cited in the literature and reported in our results in table (2), against this conclusion: The first argument is based on the Over-reaction hypothesis. Kim and Rhee (1997) argue that it is normal for volatility to drop after extremely large volatility days. Table (2) shows similar results to those of Bildik and Gulay (2003), Kim and Rhee (1997), Lehman (1989) and Miller (1989). That is the volatility of the control group stocks, which did not reach the price-limit, reduced significantly after the event day. This might indicate that regardless of the price-limit regulation, daily returns volatility will decline after it reaches a highest level. This would lead to conclude that the peaked daily returns volatility is due to overreaction by market participants and the decline is due to cooling-off result.

Figure 1: Daily Returns Volatility around Upper Price Limit Hits

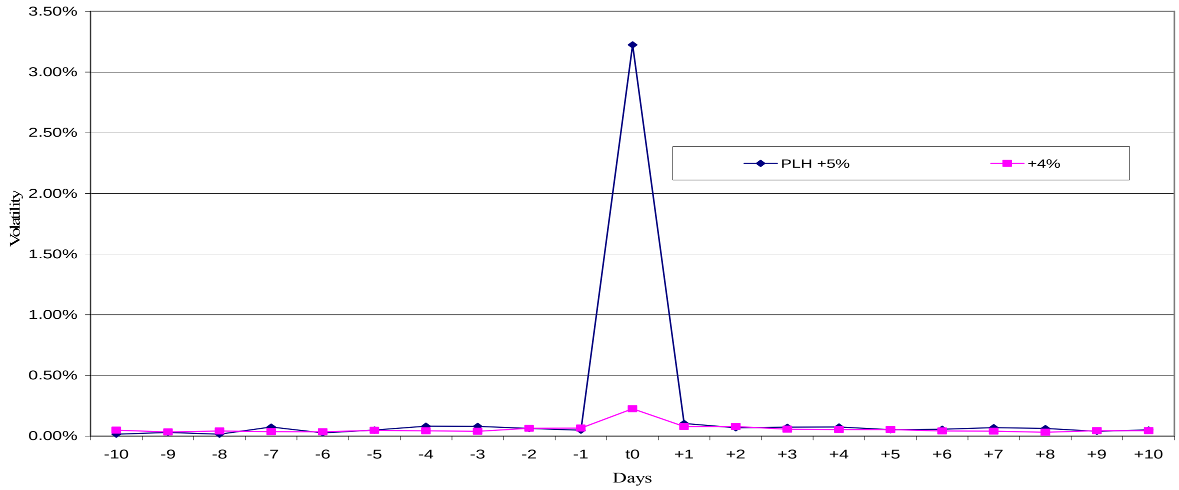
Panel A: for All Sectors



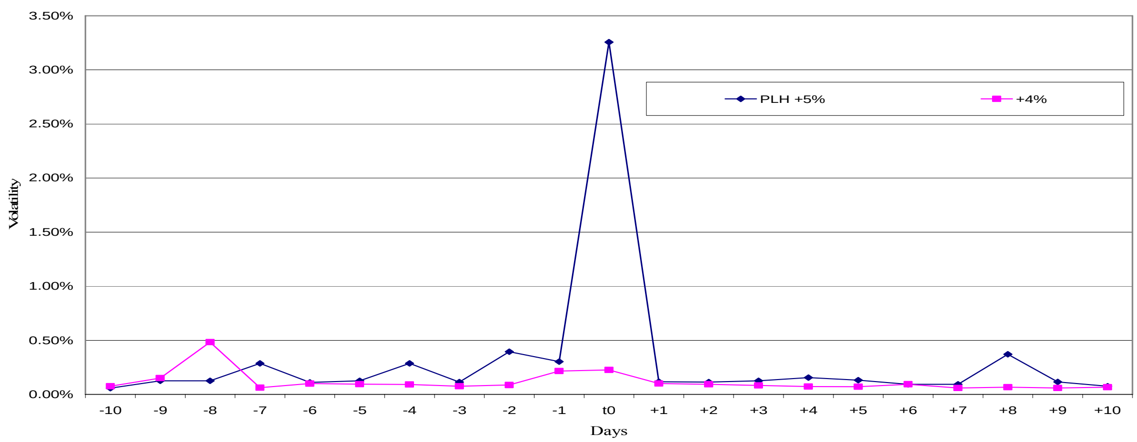
Panel B: for Banking Sectors



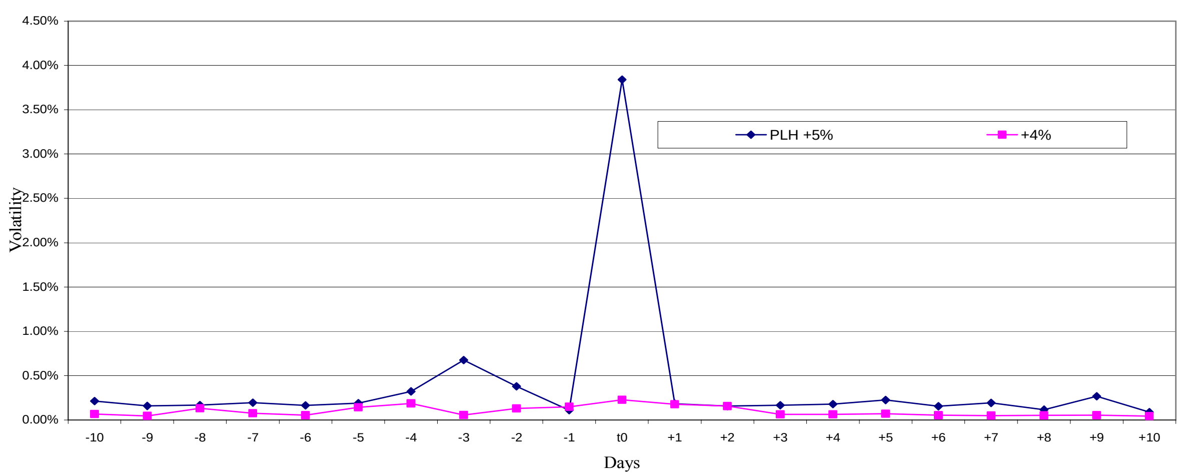
Panel C: for Insurance Sectors



Panel D: for Services Sectors



Panel E: for Industry Sectors



The second argument is based on the Spillover hypothesis. Bildik and Gulay (2003) find that the volatility of stock-hits during the post-limit period does not decrease as much as the volatility of the control group stocks. Table (2) indicates that on day +3 onward for the whole sample, the volatility of the stock-hits is larger than the volatility of the stocks in the control group, and the difference between them is significant at 5% level or less. However, there are no significant differences in the volatility of the stock-hits and those of the control group during the first two days after the event day. That is to say that the spillover hypothesis fails and, hence, it might be concluded that the price-limit technique is effective in reducing the volatility by providing a time-out to cool-off. This contradicting conclusion is very obvious in all sectors of ASE except the banking sector. In fact, there were no significant differences between the volatility of the stock-hits and those of the control stocks during all the post-limit days in the insurance and services sectors.

Our interpretation for the mixed results between the banking and the other sectors is that the banking sector in Jordan has witnessed a high volatility era during the study period 2004-2005. This is due to the huge capital inflows to Jordan from the neighbouring countries, mainly from Iraq. These funds entered the banking system, as interest-free demand deposits. Thus, the loanable funds have increased as well as the profitability and stock prices of the Jordanian banks. However, Basil II requirements have led to uncertainty in small-size banks, which in turn, increased their stock price volatility.

These findings might provide some explanation as why the banking sector has the highest price-limit hits ratio, in comparison with other sectors in ASE. Price-limit hits ratio is defined as the average number of upper and lower price-limit hits per stock. It is measured by dividing the number of price-limit hits in a sector by the number of companies listed in that sector. Using the data in table (1), it can be seen that price-limit hits ratio for banks is 9.2 hits per stock. While that of the manufacturing sector is 2.5, the services sector is 2.4 and the insurance sector is 1.7 hits. On average, there were 3.0 hits for each stock listed in both the first and second markets of ASE.

RESULTS ON LOWER LIMIT HITS

Table (3) reports the volatility in the daily returns around lower price limit hits of -5%, as well as, around the benchmark of price movement of -4%, for each sector as well as for the overall market. Also, the table reports the t-statistics according to Wilcoxon signed-rank test.

The results reported in the table are almost identical to those of the upper limit hits, reported in table (2), however, with less magnitude. Stocks-hit experiences their highest level of volatility on the day when stocks-hit reach their lowest daily price limits (day 0). The volatility of stocks-hit increased from 0.19% on day -10 to 0.23% on day -5 and jumps to 1.85% on day 0, then decrease significantly to 0.83% on day +1 and fluctuate down-ward significantly up to day +10 when it reaches 0.26%. Panel (A) in figure (2) shows the behavior of this volatility.

Sector-by-sector results in the same table reveal similar behavior, but different from those of the upper limit hits. The service sector has the highest volatility followed by the insurance sector and the manufacturing sector and, finally, the banking sector. The volatility of the banking and manufacturing sectors during post-limit-hit days are the most significant in comparison with the control group. But similar to those of the upper limit hits, none of the post-limit-hit day's volatility in the insurance and the service sectors is significant. Panels (B), (C), (D), and (E) in figure (2) show the behavior of volatility in the banking, insurance, services and industry sectors, respectively. In fact, movements in the daily returns volatility started on day -10, at which the difference from the control group was significant. But the movements eased afterward until day -5, then regained power up to the price-limit-hit day. The volatility relaxed significantly only during the post-limit hit day +1.

Table 3: Volatility in the Daily Returns around Lower Limit Price Hits

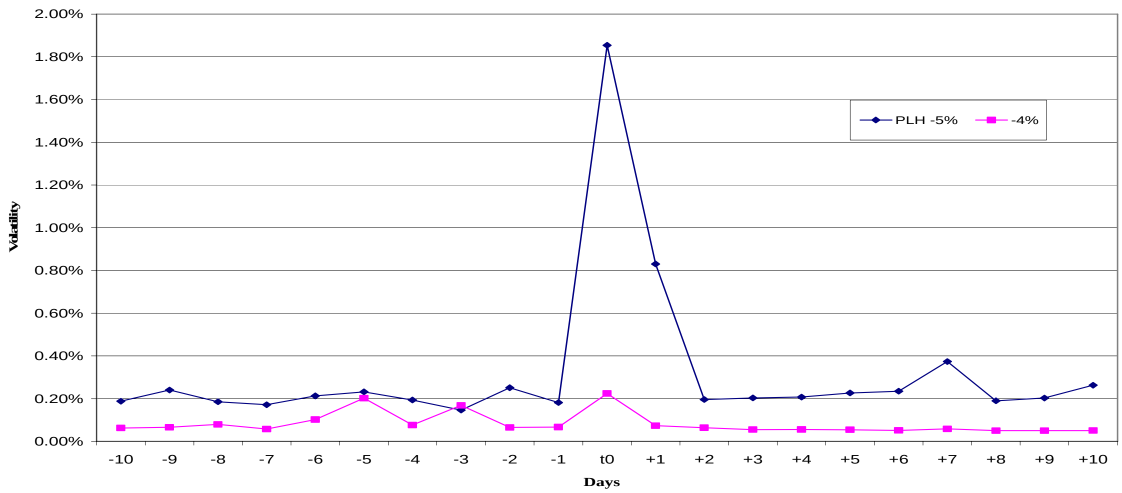
	ALL SECTORS			BANKS			INSURANCE		
Days	**PLH -5%**	**-4%**	**T-Value**	**PLH -5%**	**-4%**	**T-Value**	**PLH -5%**	**-4%**	**T-Value**
-10	**0.19%**	0.06%	-4.8705**	0.35%	0.05%	-4.4871**	**0.06%**	0.05%	-0.2699
-9	**0.24%**	0.07%	-3.2997**	0.54%	0.08%	-2.7043**	**0.03%**	0.05%	1.7391**
-8	**0.19%**	0.08%	-3.3030**	0.39%	0.07%	-4.3055**	**0.03%**	0.04%	0.6080
-7	**0.17%**	0.06%	-3.9868**	0.37%	0.07%	-3.3511**	**0.04%**	0.04%	0.0493
-6	**0.21%**	0.10%	-2.2657**	0.33%	0.31%	-0.1208	**0.02%**	0.08%	1.4443
-5	**0.23%**	0.20%	-0.2560	0.62%	0.10%	-2.8146**	**0.06%**	0.04%	-0.6696
-4	**0.19%**	0.08%	-2.9880**	0.44%	0.20%	-1.4607	**0.03%**	0.04%	0.9520
-3	**0.15%**	0.17%	0.3180	0.27%	0.27%	-0.0290	**0.03%**	0.23%	1.0922
-2	**0.25%**	0.07%	-2.6373**	0.60%	0.07%	-2.2084**	**0.02%**	0.05%	2.4323**
-1	**0.18%**	0.07%	-2.8808**	0.29%	0.09%	-2.6950**	**0.03%**	0.04%	0.2618
t0	**1.85%**	0.22%	-5.2449**	1.57%	0.22%	-3.9570**	**1.65%**	0.22%	-2.2153**
+1	**0.83%**	0.07%	-1.1616	0.35%	0.09%	-4.4154**	**0.04%**	0.06%	1.2031
+2	**0.20%**	0.06%	-5.2917**	0.38%	0.05%	-5.0741**	**0.04%**	0.05%	0.8040
+3	**0.20%**	0.06%	-5.1785**	0.39%	0.06%	-4.4920**	**0.05%**	0.04%	-0.7166
+4	**0.21%**	0.06%	-5.6114**	0.40%	0.05%	-5.0566**	**0.04%**	0.03%	-0.6395
+5	**0.23%**	0.05%	-3.4773**	0.54%	0.09%	-2.6761**	**0.02%**	0.03%	0.6144
+6	**0.23%**	0.05%	-5.4101**	0.42%	0.05%	-5.8161**	**0.05%**	0.03%	-1.2591
+7	**0.37%**	0.06%	-2.9689**	0.92%	0.08%	-2.3680**	**0.04%**	0.03%	-0.7530
+8	**0.19%**	0.05%	-6.0171**	0.40%	0.06%	-5.2155**	**0.04%**	0.04%	-0.2634
+9	**0.20%**	0.05%	-5.3211**	0.43%	0.13%	-3.0093**	**0.02%**	0.04%	1.0922
+10	**0.26%**	0.05%	-3.5553**	0.49%	0.05%	-2.6359**	**0.05%**	0.03%	-1.1385

	SERVICES			INDUSTRY		
Days	**PLH -5%**	**-4%**	**T-Value**	**PLH -5%**	**-4%**	**T-Value**
-10	**0.11%**	0.09%	-0.4599	**0.14%**	0.05%	-3.1919**
-9	**0.06%**	0.06%	-0.2937	**0.18%**	0.07%	-2.2573**
-8	**0.07%**	0.06%	-0.4754	**0.14%**	0.11%	-0.5604
-7	**0.08%**	0.07%	-0.2692	**0.11%**	0.05%	-2.9288**
-6	**0.05%**	0.11%	1.4197	**0.26%**	0.06%	-1.9819**
-5	**0.08%**	0.22%	1.0143	**0.08%**	0.26%	0.8361
-4	**0.05%**	0.07%	1.3281	**0.13%**	0.07%	-2.1108**
-3	**0.12%**	0.09%	-0.4928	**0.10%**	0.20%	0.7164
-2	**0.07%**	0.08%	0.1683	**0.16%**	0.06%	-2.7457**
-1	**0.04%**	0.08%	1.8117**	**0.22%**	0.06%	-1.9253**
t0	**2.66%**	0.23%	-2.8054**	**1.63%**	0.22%	-2.6688**
+1	**2.85%**	0.08%	-0.9951	**0.16%**	0.07%	-2.0032**
+2	**0.07%**	0.08%	0.3870	**0.18%**	0.06%	-2.9574**
+3	**0.09%**	0.07%	-0.8351	**0.17%**	0.05%	-2.7244**
+4	**0.05%**	0.06%	0.8992	**0.20%**	0.06%	-3.1872**
+5	**0.07%**	0.06%	-0.1343	**0.15%**	0.05%	-2.6394**
+6	**0.08%**	0.07%	-0.2483	**0.24%**	0.04%	-2.8167**
+7	**0.11%**	0.08%	-0.5601	**0.22%**	0.05%	-2.1574**
+8	**0.04%**	0.06%	1.5373	**0.16%**	0.05%	-3.7664**
+9	**0.08%**	0.04%	-1.0758	**0.16%**	0.04%	-3.3639**
+10	**0.04%**	0.06%	2.0326**	**0.29%**	0.05%	-2.5491**

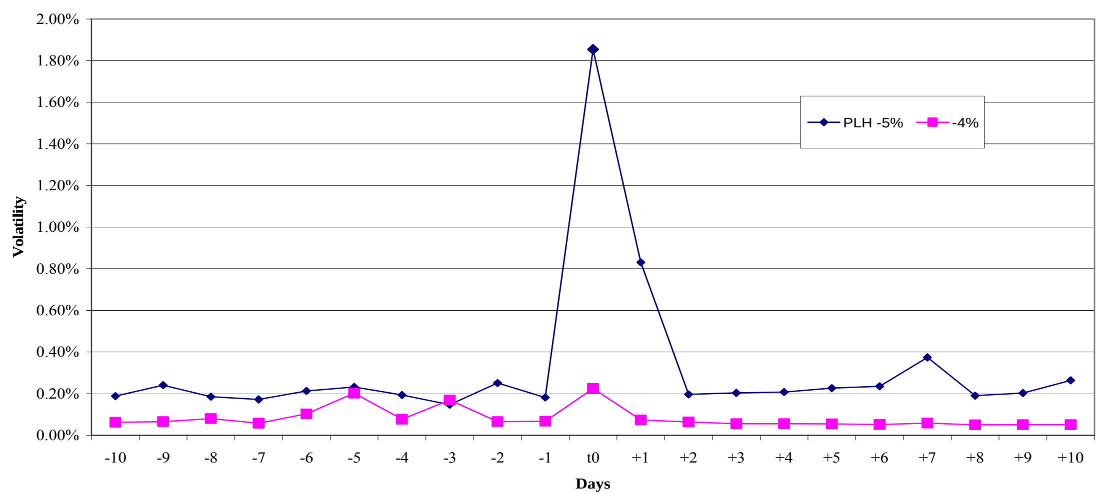
Note: Stocks are categorized into two groups (-5% and -4%) based on the level of their price movements on Day 0 . Stocks 5% denote stocks that reach their lower daily price limit (-). The main categories are presented for downward price movements. Each number (in %) in the table represents the volatility of daily returns at and around price limit hit for each sector during the period 1/1/2003 to 31/12/2004. T-value is computed according to Wilcoxon signed-rank test.

Figure 2: Daily Returns Volatility around Lower Price Limit Hits

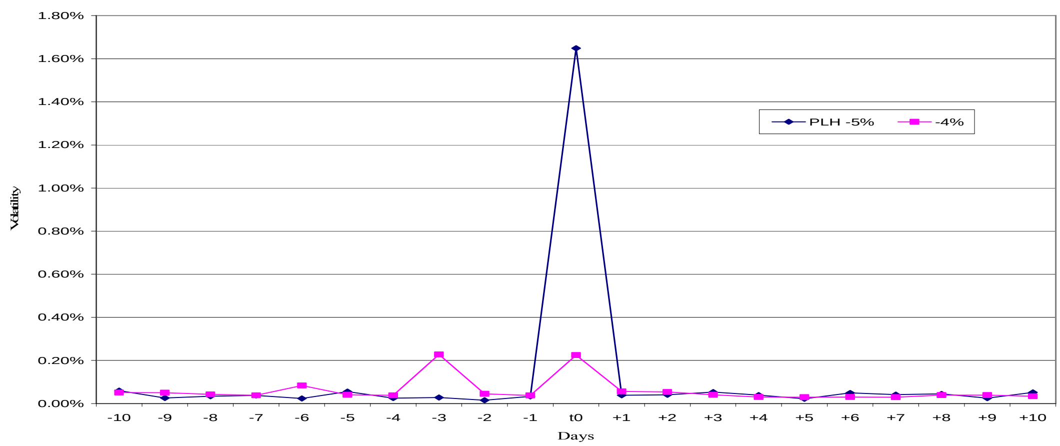
Panel A: for All Sectors



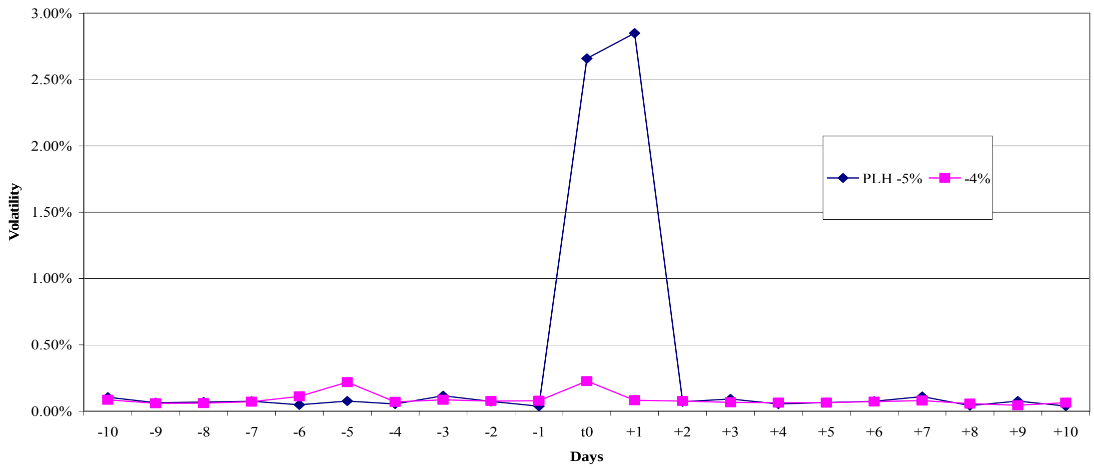
Panel B: for Banking Sectors



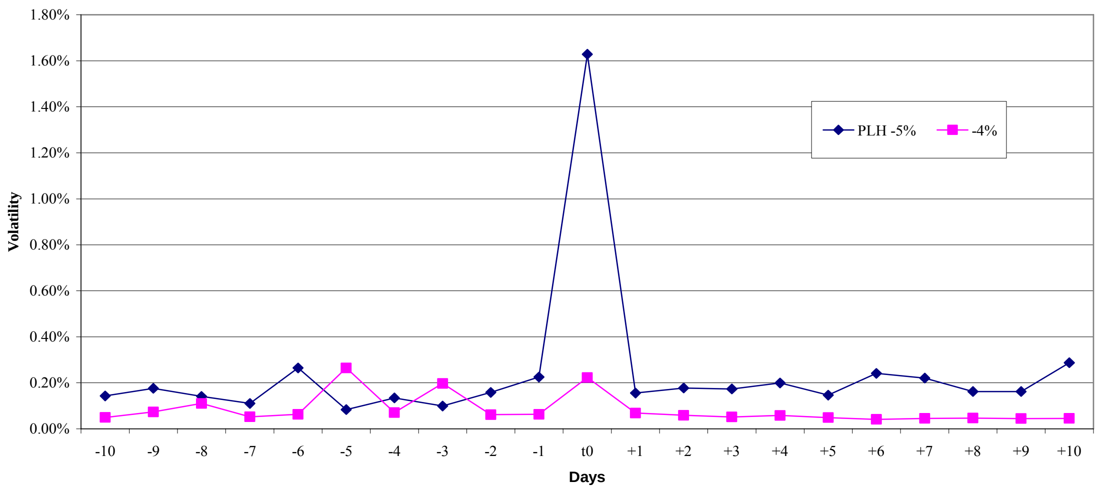
Panel C: for Insurance Sectors



Panel D: for Services Sectors



Panel E: for Industry Sectors



SUMMARY AND CONCLUSION

This paper empirically investigated the behavior of daily stock return volatility around the price limit hits for a sample of 159 (189) securities listed in ASE for the years 2004 (2005). It investigates whether daily return volatility for stock that hit hits price limits are lower (higher) in the post limit hit period than in the pre limit hit period, which is consistent with the overreaction hypothesis (volatility spill over hypothesis).

The methodology employed was based first on identifying the days where the high (low) price matches its previous day's closing price plus (minus) the price limit, and then on measuring the price volatility around the days, when price hits the limit. Our results indicate that stocks-hit experiences their highest level of volatility on the day when stock-hits reached their upper daily price limits of 5% (day 0), and decreases significantly one day after the hit. Similar results are found when stock hits reach their lower daily price limits of -5%, however with less magnitude. Results on sectors reveal that the banking sector has the highest volatility, and its volatility is the most significant during post limit hit days in comparison to the other sectors when the stock-hits reach their upper daily price limit. However, when the stock-hits reach its lower daily price limit, the service sector has the highest volatility as compared to the other sectors in the industry. Therefore, our results are consistent with the overreaction hypothesis and that the price-limit technique is effective in reducing the volatility by providing a time-out to cool-off.

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