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# Essays on International Financial Markets

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# Essays on International Financial Markets

By

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# Dedication

I dedicate the work herein to my beloved parents, Rihuan Li and Lanting Meng.

# Acknowledgements

I would like to thank all members of my committee for their assistance. My gratitude is immeasurable for my advisor, Li Gan, who has been supporting and taking care of me throughout my entire Ph.D program. This would not have been completed without his invaluable guidance, encouragement and counsel over the years. I also owe a special debt to Ron Kaniel and Laura Starks, who have been giving me tremendous help in the field of Finance. Finally, I would like to thank my husband, Geng Yang, for his love, encouragement and understanding.

# Essays on International Financial Markets

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This dissertation focuses on three issues on international financial markets. In the first essay, we examine an investor visibility event, a high volume shock, across countries to determine whether the event is pervasive and whether systematic differences across countries in their demographics, market characteristics and investor confidence affect the magnitude of the resulting return premium. We find that the high volume return premium is a persistent phenomenon found in both developed and emerging markets. Using Merton's (1987) investor recognition hypothesis as a guide, we find the magnitude of the premium is associated with country characteristics hypothesized to affect returns subsequent to a change in a stock's visibility. In the second essay, we investigate whether the liquidity risk documented by Pastor and Stambaugh (2003) for the U.S. market is a common risk factor by using data from 19 international stock markets. For many international

markets, we find strong evidence that on the cross-section expected stock returns are associated with the sensitivities of stock returns to innovations in market liquidity. Stocks with higher sensitivities to market liquidity have significantly higher expected returns, in magnitudes comparable to, in some cases higher than, that of the U.S. market, even after controlling for exposures to the market return, size, value and momentum factors. Therefore, our research lends substantial support to the market liquidity as a priced systematic risk. In the third essay, we use a “natural experiment": a stock is traded in two marketplaces, where one is subject to price limits while the other is not, to identify the effect of price limits. We use the information on the U.S. market to estimate the price differential between the two claims and then predict what the price would have been on the Tokyo Stock Exchange if there were no price limits. We then predict the moments for the days that price limits were hit and use the predicted moments to compare with the observed stock moments. We conclude that price limits do not have a significant effect on the means and variances, so the proposed intent of having price limits is not supported by our analysis.

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# Chapter 1

# Introduction

The past decades have seen dramatic development in international financial markets. During the same time, financial economists have been increasing their effort to explore and understand issues related to international financial markets. On one hand, researchers have started looking into individual financial markets outside the United States. One area that many are interested in is to extend research centered on the U.S. markets into international markets (see Keim, Ziemba, and Moffatt (2000) for a comprehensive review). Studies falling into this category provide valuable evidence to demonstrate to what extent the results found for the U.S. market are robust and/or unique. On the other hand, researchers have also gone beyond studying each international market at the individual country level, but have become more and more interested in the interrelationships across financial markets in different countries. Studies of this nature greatly enhance our understanding of the globalization, integration and the still-existing differences of international financial markets (Bekeart and Harvey, 2000; Bekeart, Harvey and Lumsdaine, 2002b; LaPorta, Florencio, Shleifer and Vishny, 1998; Griffin, Ji and Martin, 2003).

In this dissertation, we focus on three issues in the field of international financial markets. In the first essay, we examine the effect of an investor visibility event on share prices by using international data. Our study is not only to examine whether the event is pervasive, but the across-country analysis is also to explain why investor visibility events have return effects and what factors determine the magnitude of the effects. The particular visibility event we examine is a high volume shock to a stock and the subsequent return premium (the high volume return premium), which was first documented in the United States by Gervais, Kaniel and Mingelgrin (2001). We then use Merton's (1987) investor recognition hypothesis as a guide to which characteristics should be important in defining the event's effects.

Merton's (1987) investor recognition hypothesis is a natural guide because it implies that incomplete information diffusion across investors affects their trading behavior and the resulting security values. Because of incomplete information diffusion, some investors are unaware of certain securities and consequently do not hold those securities in their portfolios. In such a case, Merton shows that investors will be inadequately diversified and will demand a premium for taking on nonsystematic risk, causing a stock's required rate of return to depend on its investor base. Merton's hypothesis relies on the particular characteristics of an information environment in which, due to different information structures, the awareness of a firm's securities may be limited to a subset of the potential investing population. This limitation of a stock's investor base, i.e., the stock's limited visibility among investors, means that if the stock achieves increased visibility and consequently, increases its investor base, there should be a reduction in the cost of capital and a concomitant increase in the firm's market value. Thus, the implications of the investor recognition hypothesis should vary across markets with different trading and demographic characteristics as these characteristics affect the costs of being informed and the degree of a stock's visibility. Examining data across 41 countries provides a unique opportunity to test how return effects from investor visibility events are related to the hypothesized characteristics.

In the second essay, we investigate an important issue in empirical asset pricing within a broad international setting. That is, we use international financial data to examine whether market-wide liquidity is a priced state variable that affects investors' welfare. Liquidity seems to be such a state variable because investors holding a security whose lowest returns tend to occur with lower liquidity should be compensated with some return premium. Using the U.S. stock market data over a 34-year period, Pastor and Stambaugh (2003) find that expected stock returns are related cross-sectionally to the sensitivities of returns to fluctuations in aggregate liquidity. They create a monthly liquidity measure, an average of individual-stock measures estimated with daily data, based on the idea that order flow induces greater return reversals when liquidity is lower. Over their sample period, the average return on stocks highly sensitive to liquidity exceeds that for stocks with lower sensitivities to liquidity by 7.5% annually, adjusted for exposures to the market return, size, value, and momentum factors.

Given the U.S. is the only market that Pastor and Stambaugh (2003) study, and arguably it is the most liquid equity market of the world, one may naturally question whether their finding is a result of data mining. In chapter 3, we address the question how robust their finding is and whether it can be extended to other countries' markets. Our first step is to apply their analysis to 18 international markets to see whether similar results can be found elsewhere of the world. Indeed, we find that liquidity risk is priced in international stock markets outside the U.S. Specifically, in a number of those markets, the average return on stocks with higher sensitivity to market liquidity exceeds that for stocks with lower sensitivity significantly, both in economic and statistical terms, even after adjusted for other asset-pricing factors. Our second step is to link the liquidity premium in each country to a most important "real" variable of the economy, i.e. the economic growth, denoted by the gross domestic product. Consistent with evidence supporting other factors, such as the market return, size and value factors, to be risk-based asset pricing factors, we find that market liquidity seems to have reasonable predictive power to future economic growth. Therefore, our out-of-sample analysis favors a risk-based explanation to stocks' liquidity premium.

In the third essay, we turn our attention to an individual country – Japan. Japan's stock market ranks the second largest in the world in terms of market capitalization, but interestingly, it employs a price limit system to prevent stock price from fluctuating beyond a certain degree on any given trading day. We notice that many large Japanese stocks are also traded as American Depository Receipts (ADRs) in the U.S., which is not subject to price limits. Therefore, we are able to use a "natural experiment" comparing a stock which is traded in these two marketplaces, where one is subject to price limits while the other is not, to identify the effect of price limits.

We use the information on the U.S. market to estimate the price differential between the two claims and then predict what the price would have been on the TSE if there were no price limits. We then predict the moments for the days that price limits were hit and use the predicted moments to compare with the observed stock moments. We conclude that price limits do not have a significant effect on the means and variances, so the proposed intent is not supported by our analysis.

# Chapter 2

# Investor Visibility Events: Cross-Country Evidence

## 2.1 Introduction

The effects of increased investor visibility on share prices have received considerable attention recently. For example, Gervais, Kaniel and Mingelgrin (2001) find that high volume shocks are followed by return premiums. Barber and Odean (2005) find that stocks are more likely to be purchased by individual investors on days on which the stocks experience high abnormal trading volume, are in the news or experience extreme price moves. Grullon, Kanatas and Weston (2004) provide evidence that firms with greater advertising expenditures have a larger number of investors and better liquidity of their common stock.

What has not been fully explained is why investor visibility events have return effects and what factors determine the magnitude of the effects. We provide new insights into these issues by examining a particular investor visibility event across countries that possess different market and investor characteristics. We focus on how the existence and magnitude of the return effects associated with the visibility event vary with these characteristics. The particular visibility event we examine is a high volume shock to a stock and the subsequent return premium (the high volume return premium), which was first documented in the United States by Gervais, Kaniel and Mingelgrin (2001). We then use Merton's (1987) investor recognition hypothesis as a guide to which characteristics should be important in defining the event's effects.

Merton's (1987) investor recognition hypothesis is a natural guide because it implies that incomplete information diffusion across investors affects their trading behavior and the resulting security values. Because of incomplete information diffusion, some investors are unaware of certain securities and consequently do not hold those securities in their portfolios. In such a case, Merton shows that investors will be inadequately diversified and will demand a premium for taking on nonsystematic risk, causing a stock's required rate of return to depend on its investor base. Merton's hypothesis relies on the particular characteristics of an information environment in which, due to different information structures, the awareness of a firm's securities may be limited to a subset of the potential investing population. This limitation of a stock's investor base, i.e., the stock's limited visibility among investors, means that if the stock achieves increased visibility and consequently, increases its investor base, there should be a reduction in the cost of capital and a concomitant increase in the firm's market value. Thus, the implications of the investor recognition hypothesis should vary across markets with different trading and demographic characteristics as these characteristics affect the costs of being informed and the degree of a stock's visibility. Examining data across 41 countries provides a unique opportunity to test how return effects from investor visibility events are related to the hypothesized characteristics.

Our paper proceeds as follows. In the following section, we present the data and methodology for measuring the investor visibility event, the high volume return premium. In the cross-country empirical tests, we find the high volume return premium to be a pervasive phenomenon that exists not only in the U.S., but in almost all developed markets and in many emerging markets. In Section 2.3, we turn to the question of whether the effects of the investor visibility event vary systematically across countries. Using Merton's investor recognition hypothesis (1987) as a guide to which country characteristics should be important in determining the magnitude of the visibility event's effects, we develop predictions for the relation between the characteristics and the returns to a stock with changed visibility arising from a high volume shock. We then test these predictions in Section 2.4 by employing measures of the high volume return premium as the dependent variable. We find evidence consistent with most of the derived predictions. In particular, we find that the magnitude of the high volume return premium is associated with the country characteristics expected to be related to the importance of a stock's visibility: Investor demographics, information dissemination, the country's stock market composition and investor confidence in the country's markets. Consistent with the implications of Merton's hypothesis, we find that the return premium on a stock following an investor visibility event is increasing in the extent to which the stock is less visible, a priori, to investors, decreasing in the potential investor base in the country (as reflected in a proxy for demographics of country), and decreasing in the market's aggregate risk aversion (as reflected in the degree of investor confidence in the market). We find further that the high volume return premium is not a result of liquidity changes in the stock following the high volume shock.

These results are consistent with those of Gervais, Kaniel and Mingelgrin (2001) for the high volume return premium in the United States equity market. The results are also consistent with previous studies that provide support for the implications of Merton's (1987) investor recognition hypothesis in that changes in stock visibility are an important aspect of investor decision-making (e.g., Kadlec and McConnell, 1994; Kang and Stulz, 1997; Foerster and Karolyi, 1998; Amihud, Mendelson, and Uno, 1999; Dahlquist and Robertsson, 2001; Gervais, Kaniel and Mingelgrin, 2001; Chen, Noronha, and Singal, 2003; Grullon, Kanatas and Weston, 2004).[1]

A key distinction between these previous studies and ours is that their results are within-country results while our results are cross-country results.

The recent financial liberalizations and increasing foreign investment in many emerging stock markets also have implications for our tests of investor visibility events. We consider these implications in Section 2.5 and provide our concluding comments in Section 2.6.

[1] Additional theoretical papers include Basak and Cuoco (1998) and Shapiro (2002).

## 2.2 The High Volume Return Premium across Markets

### 2.2.1 Methodology and Data

Our measure of the consequences of an investor visibility event is the return premium due to an extreme shock to a stock's trading volume, i.e., the high volume return premium. We use the Gervais, Kaniel and Mingelgrin (2001) methodology to measure the increased return (the premium) that results from the volume shock. We begin with a 70-day trading interval, divided into three periods for the analysis: the reference, formation and testing periods. The first 49 days constitute the reference period, the purpose of which is to provide a typical distribution of volume for each stock individually. There is then a 1-day formation period, the purpose of which is to measure whether a stock has an extreme volume shock on that date (as compared to its own volume distribution during the preceding 49-day reference period). Stocks are then grouped into three portfolios according to whether they have extremely high, normal, or extremely low volume on the formation date relative to their own typical volume in the preceding reference period. The last 20 days of the interval provide the testing period, which is used to assess the returns on these portfolios following the volume shock. Figure 2.1 illustrates this time sequence.

Since many countries have a relatively short time series of volume data available, for most of our analysis, as Figure 2.1 shows, each following reference period in the sequence begins so that the following testing period begins one day beyond the previous testing period. This approach provides us with non-overlapping test periods, but overlapping reference periods. We allow the reference periods to overlap in order to make full use of our time series of data, however, we do not allow the testing periods to overlap.

We define a stock as having extreme trading volume during the one-day formation period if the stock's trading volume is in the top or bottom twentieth percentile of trading volume as compared to its own distribution of volume over the 49-day reference period. Each stock meeting these criteria is defined as being in an extreme trading volume portfolio (either high or low). All other stocks are classified as having normal volume in the formation period.[2,3]

We employ returns and volume data for shares traded in 41 countries. For the United States, we obtain returns and volume from the CRSP database for all firms listed on the New York Stock Exchange. For all other countries, we obtain returns and volume from Datastream International. Table 2.1 provides the list of countries used in our study along with the characteristics of the volume data for that country: the starting date of the sample period, the number of 70-day intervals constructed from the available time series and the average number of stocks in each interval. The time period for our analysis is limited by the availability of volume data for many countries. Although Datastream has returns from earlier periods, we also need volume data, which

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[2] Although Gervais, Kaniel and Mingelgrin (2001) define extreme volume stocks as those in the top or bottom tenth percentiles, we use the top or bottom twentieth percentiles because of the fewer number of stocks available for many countries. (The cost of using a broader definition of extreme volume, as we do, is that it could lessen any significant differences between the high-volume and low-volume portfolios.) If we limit the analysis to countries with sufficient data to use the 10% cut-off, the results are stronger. However, this limitation requires omitting many countries.

[3] A potential issue is whether allowing the reference periods to overlap results in some stocks being selected more often than expected. As Section A.1 of Appendix A shows in more detail, this is not the case.

is not available until the 1980's, or even 1990's, for most countries (the exceptions being the U.S. and Canada). In order to make use of the greatest amount of data possible for any individual country, we allow sample periods to vary across countries. Thus, although every country's sample period ends on June 30, 2001, the number of 70-day trading intervals ranges from a high of 445 intervals for the United States (volume data available since 1963) to a low of 27 intervals for Brazil (volume data available since 1999), with an average of 142 intervals. Most of the countries have sufficient time series to provide more than 100 intervals for the analysis.[4]

To be included in a country's sample, a stock must be a domestic stock traded on the country's primary exchange and included in Datastream for the previous year.[5] In many of these markets, a large number of stocks are traded

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[4] The lack of a sufficient times series and cross-section of data for many countries also means that we cannot employ some of the additional analyses used in the Gervais, Kaniel and Mingelgrin (2001) study. They examine both daily and weekly data, we limit our analysis to daily data because of the limited times series for many countries. In addition, we cannot condition on returns on the formation day as do Gervais, Kaniel and Mingelgrin (2001). However, it should be noted that when we conduct the conditioning analysis only with the countries that had enough data to do so, the results when conditioning on normal returns are indeed stronger. Further, in part of their analysis, Gervais, Kaniel and Mingelgrin (2001) use longer testing periods of 50 or 100 days. We are unable to conduct such longer-term analyses due to the lack of a longer time series of data for many countries.

[5] The primary exchange for a country is defined as the exchange that has the greatest market capitalization and the largest number of stocks traded. There are two exceptions to this definition: China and Poland. Unlike the other countries in our sample, these countries' two largest exchanges are of comparable size. Consequently, for these two countries we combine their two largest exchanges into one market for our analysis. (For purposes of this study, we consider Hong Kong as a separate country from China as it was separate for the majority of the sample period.) We focus on only one exchange to avoid complications from differences in visibility across exchanges. Kadlec and McConnell (1994) find evidence of such differences for U.S. exchanges.

only occasionally. Consequently, the number of stocks for each country used in the samples is reduced from what is available on Datastream. We also employ other filters designed to ensure that the nontrading, outliers, or important firm capital events do not affect our analysis. For the first 49 days of each 70-day trading interval, the stock must have traded for at least 40 of those days and its local currency price must not be in the lowest five percentile of stock prices in the country's sample for the year.[6] If there is an earnings or dividend announcement during the reference or formation period, we omit the stock from that interval. Finally, the stock cannot have had any major capital events during the year previous to the formation date.[7]

Beyond the filters for individual stocks, we also consider whether a country had enough stocks trading to be able to construct meaningful within-country portfolios. Thus, we omit any country whose major exchange did not have data, on average, for more than 20 stocks per trading interval. This criterion resulted in the omission of 9 countries with stocks available on Datastream: Colombia, Venezuela, Russia, Kenya, Peru, Cyprus, Hungary, Czech Republic, and Zimbabwe, leaving us with 41 countries.

Table 2.1 shows the large variation across the countries in the number of stocks included in the intervals. Even with our restriction of eliminating any country that averaged fewer than 20 stocks in the available intervals, some of

[6] Because of the lack of trading for many of the stocks in our sample, we must allow for some nontrading. If we do not allow some nontrading, we would lose too many observations for a number of the countries.
[7] We define major capital events as events such as mergers, delistings, partial liquidations, and seasoned equity offerings.

the remaining countries still had very few stocks available. For example, Morocco and Argentina have less than 30 stocks with the required data available. Across countries the average number of stocks in an interval is 179.

For each of the 41 countries remaining in the sample, Figures 2.2 and 2.3 show the spreads of return differences between the high extreme volume, normal volume and low extreme volume portfolios over the twenty-day test periods. Figure 2.2 reports the results for developed markets and Figure 2.3 reports results for emerging markets. The mean 20$^{th}$ day spread between the high-volume and low-volume portfolios as well as a t-statistic for the magnitude of the spread are given in Table 2.2.[8] Panel A presents the spreads for the developed markets, divided by whether the market is in a G-7 country or not. Panel B presents the spreads for the emerging markets.

Figure 2.2 and Panel A of Table 2.2 show that for the developed markets, the results are striking in their similarity to the results for the United States and in their pervasiveness across markets. Figure 2.2 demonstrates that in nearly all cases the high extreme volume portfolios have greater excess returns over the test periods than do the normal or low extreme volume portfolios. The figure also indicates that in nearly all cases, the normal volume portfolios outperform the low extreme volume portfolios.

The table shows that 17 of the 20 developed markets exhibit spread differences between the high and low extreme volume portfolios that are

[8] All t-statistics in our regressions are based on the Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors.

significant beyond the five percent level. An additional market (Netherlands) exhibits a difference significant beyond the ten percent level. Only two of the smaller developed markets (Norway and Belgium) show no significant differences between the excess returns of their high and low extreme volume portfolios. It should also be noted that as shown in Table 2.1, these two countries have considerably fewer than average stocks in their intervals (and Belgium has considerably fewer intervals), which lessens the power of the tests. We explore this issue further in Section A.1 of Appendix A, where we show that indeed it does appear to be a power issue. The last line in Table 2.2 provides the results for the developed markets as a group. Their pooled mean 20$^{th}$ day spread is 1.75 with a t-statistic of 22.15.

Figure 2.3 and Panel B of Table 2.2 report the results for the emerging markets. The figure and table indicate that the emerging market country spreads are not quite as well-defined over the twenty-day test periods as are those of the developed markets. The figure shows that in the majority of the cases, the high volume portfolio return appears to be greater than the returns on the other two portfolios, and according to Table 2.2, the spread is significantly different from zero for 14 of the 21 emerging markets included in our study. When we pool the stocks on an equal-weighted basis across the emerging market countries, we find a mean 20$^{th}$ day spread of 2.90 with a t-statistic of 4.29.

To ensure that systematic risk is not a factor in the high volume return premium in general, we compare the betas of high volume to low volume stocks and in most cases there was not a significant difference between them.[9] In the few cases in which there was a significant difference, it was often in the opposite direction to what would be expected if systematic risk were the explanation for the high volume return premium.

In sum, the vast majority of developed countries and most emerging market countries show significant spreads between their high-volume and low-volume portfolios. On a pooled basis, the magnitude of the premium for both markets is quite large for a twenty-day period.

### 2.2.2 Reference Return and Zero Investment Portfolios

If the high volume return premium is a persistent phenomenon in each of the sample countries, we should be able to form portfolios to take advantage of it. To test this, we construct two types of country portfolios: zero-investment and reference return portfolios for each country. To create the zero-investment portfolio, at each portfolio formation period we take a long position for a total of one dollar in all of the high volume stocks in a country and a short position for a total of one dollar in all of the low volume stocks in that country. We equally weight the stocks in each long and in each short position of the country's portfolio and then hold the portfolio for the twenty-day testing period without rebalancing.

We construct each country's reference return portfolio (e.g., Conrad and Kaul, 1993; Lyon, Barber, and Tsai, 1999) by investing a dollar long into

[9] The results for the differences in the betas for the high and low volume stocks are shown in Section A.3 of Appendix A.

each stock that has high extreme volume and offsetting the long investment by shorting a dollar's worth of a size-adjusted reference portfolio. Correspondingly, we invest a dollar short into each stock that has low extreme volume and offset it by a dollar long investment in a size-adjusted reference portfolio. As in the zero-investment portfolio, the reference return portfolio is held for a twenty-day testing period without rebalancing.

Table 2.3 presents the results of these alternative investment strategies.[10] The results correspond to those presented in Table 2.2, in which we measured the spread between the returns of the high volume and low volume portfolios. In the case of the reference return portfolios for the developed countries, the only countries that do not show significantly positive excess returns are Norway and the Netherlands. In any of the other 18 countries, a strategy of going long in the high volume stocks and short in the low volume stocks would result in significantly positive returns over the twenty-day holding period. These returns range from 0.16% in Austria to 0.82% in Canada. For the zero-investment portfolios, 15 of the 20 countries have significantly positive returns, with the returns ranging from 0.65% in Austria to 1.59% in Singapore. In general, the results for the developed countries show that the high-volume return premium is an important effect, which is pervasive across markets.

Although the high-volume return premium is not as persistent in the emerging market countries as in the developed markets, as Table 2.3 shows,

[10] The specific equations for calculating the zero-investment and reference return portfolio returns can be found in Gervais, Kaniel and Mingelgrin (2001).

we find a significant positive return in seven of the emerging markets and none of the emerging markets has a negative return.[11]

In summary, Tables 2.2 and 2.3 show that for almost all developed markets, and for some of the emerging markets, extreme volume shocks predict significant positive returns. Further, it should be noted that even for the countries without significantly positive returns to these strategies, there are no significantly negative returns.

### 2.3. Cross-country Determinants of the Effects of Investor Visibility

Having established that our visibility event, the high volume return premium, exists across many countries, we next turn to the important question of what drives the premium. To do so, we employ Merton's (1987) investor recognition hypothesis as a guide for how different country characteristics would be expected to affect the magnitude of the return effects from a visibility event. Merton (1987) hypothesizes that when investors do not have information about stocks, i.e., are unaware of the stock, a shadow costs exists. He then shows that the magnitude of this shadow cost depends on the following four factors: investors' aggregate risk aversion, the firm's unique risk, the firm's proportional investor base (i.e., the proportion of investors who are aware of the firm) and the size of the firm relative to the aggregate wealth of

[11] Similar to the previous discussion, the lack of results in these markets could be a result of low power of the tests due to the limited observations. We explore this possibility in Appendix A.

investors in the firm.[12] Thus, when a high volume shock results in changed visibility for a firm, the degree to which the stock's expected return changes depends on the market risk aversion, the firm's unique risk, the firm's investor base and the size of the firm relative to the firm's investors' wealth. For our tests, we are interested in the variables that would vary systematically across markets, primarily those that are related to the markets' investor bases.

### 2.3.1 Characteristics that Affect the Investor Base

A firm's investor base depends on the demographics of the potential investor base as well as differences in information diffusion across those investors. We first examine the demographics of countries' markets to derive proxies that capture the systematic differences in the countries' investor base. We then examine the characteristics of the information structure in the financial markets as these structures affect the proportion of investors who are aware of a particular stock.

#### 2.3.1.1 Demographics

A country's demographics influences its relative investor base and consequently, should influence the magnitude of the return premiums from changes in the visibility of stocks in that country. We construct two variables to proxy for the size and sophistication of a country's investor base: the number

[12] Kadlec and McConnell (1994) and Chen, Noronha, and Singal (2003) use Merton's (1987) shadow cost to test for changes in stock value upon being listed on the NYSE or added to the S&P 500 Index, respectively.

of listed companies per urban population (in millions) and the level of education in the country (secondary school enrollment). For most countries we derive these two demographic measures from data obtained from Global Prospectus.[13]

The number of listed companies per million of urban population provides a relative measure of the investor base for each stock in that country. Although a better demographic measure would be the proportion of individual investors in the stock market, we do not have access to this data for markets outside the U.S.[14] Ceteris paribus, the more stocks traded per potential investor, the less likely a given stock would be visible to all investors and the more likely the stock would require visibility events such as volume shocks to increase investor awareness. Consequently, we expect the high volume return premium to be increasing in this measure. Table 2.4 provides descriptive statistics for the demographic and market characteristics. For our sample of 41 countries, the median number of listed companies per million of urban population is about 22 companies. Some countries have very few listed companies relative to the size of their populations, (e.g., China (1.5), Mexico

[13] The one exception is that Global Prospectus does not include information on Taiwan. We obtain the data on Taiwan from Standard and Poor's *Emerging Stock Markets Factbook* and from Taiwan's statistical yearbook on their website.

[14] The use of number of listed companies per million of urban population is also imperfect because it assumes a sufficient percentage of the population is invested in stocks to begin with. We use urban population rather than general population to achieve a better proxy, because we assume an urban population is more likely than a rural population to invest in a country's equity markets. If the market has few stocks per urban population, but the urban population is not representative of investors, then we are less likely to find a significant association between the variable and the high volume return premium.

(3.0) or Indonesia (3.3)). Other countries have a larger number of listed companies relative to their urban populations (e.g., Singapore (66.0), Australia (76.3) or Japan (93.7).

Secondary school enrollment provides an alternative proxy for the country's demographic characteristics as it provides a general measure of the population's education level. The measure is defined as the ratio of total secondary school enrollment, regardless of age, to the population of the age group that officially corresponds to the level of secondary school education. That is, it is the percentage of the population that should be in secondary school that actually is in secondary school. We expect the general level of a country's education to be correlated with the sophistication of the individual investors, which is the measure we would really like to have. The more highly educated the people in a country, the greater their accessibility to financial information and the more aware these investors should be of stocks, ceteris paribus, and there should be relatively fewer uninformed individual investors in the base.[15] Thus, the high volume return premium should be decreasing in the country's level of education.

[15] Bekaert, Harvey and Lundbland (2001) find that countries with higher education levels (proxied by secondary school enrollment) show stronger increases in economic growth following financial liberalizations. Similar to the caveat with our other demographic variable, if the secondary school enrollment is an inadequate proxy for the level of investor sophistication, then we should find no significant association with the high volume return premium.

#### 2.3.1.2 Equity Market Characteristics

In Merton's (1987) description of the types of stocks expected to have less investor awareness, he points out "neglected" stocks as investigated by Arbel, Carvell and Strebel (1983). Stocks are more likely to be "neglected" if they trade in a market dominated by a few large stocks or industries. If the dominant stocks are most visible during normal times, then the visibility of the other stocks, which are less visible in general, would be considerably enhanced by a high volume shock.

We employ two measures for whether a market has dominant stocks (and consequently potentially neglected stocks): a measure of the range of firm sizes and a measure of industry concentration. The range of firm sizes is defined as the ratio between the market value of the average tenth decile firm to the market value of the average second decile firm. As the descriptive statistics in Table 2.4 show, there tends to be large variation in this variable across countries. For example, while the market value ratio is 243 for the United States, it is 932 for Australia, suggesting that for some countries there is a sizeable range between the large and small companies. The market value ratio, thus, reflects the degree to which large stocks could normally mask smaller stocks. The latter would then need some type of additional visibility for investors to be aware of their presence.

Similarly, if a market is dominated by a few industries, then a high volume shock for stocks in other industries should contribute significantly to increased visibility for stocks in the less dominant industries.[16] To measure industry domination, we employ the share of the country's market capitalization accounted for by the largest three industries in the market. Table 2.4 shows that for at least half of the countries in the sample, the share of the stock market represented by the largest three industries is greater than 50%, a substantial dominance by these industries. In fact, in Brazil the three largest industries represent 89% of the market, compared to the United States, where the three largest industries represent less than 25%.

For both of these measures of potential market domination or concentration, the investor recognition hypothesis predicts a positive relation between the measures and the magnitude of the high volume return premium. It should be noted, however, that there are potential offsetting effects from market concentration. There needs to be a sufficient number of stocks for high concentration to matter and result in a high volume return premium. If there are not a sufficient number of stocks overall combined with the high concentration, then a high volume premium may not exist. For example, at the extreme, if there were only two stocks with one much larger than the other, investors would still be aware of the second stock even without a volume shock.

A third measure of the information in the country's market is a measure of the proportion of systematic versus firm-specific information, the average $R^2$ of the market model. As Roll (1988) points out, an interpretation of the $R^2$ of

[16] In the vernacular of Arbel, Carvell and Strebel (1983) and Merton (1987), these could be considered "neglected" industries.

the market model is that it provides an indication of the relative level of market-wide versus firm-specific information in equity securities. If the market model explains the firm's return well, then less firm-specific information is reflected in a country's stock prices. The implication is then that the country's securities would be more sensitive to changes in visibility. Table 2.4 indicates that the mean $R^2$ is 0.12 with a standard deviation of 0.10. This number is comparable to that of Morck, Yeung, and Yu (2000), who use weekly data for 37 countries for 1995 and find a mean $R^2$ of 0.169 and a standard deviation of 0.099.

### 2.3.2 Aggregate Market Risk Aversion

Merton's (1987) hypothesis also implies that systematic differences in aggregate market risk aversion across countries should affect the size of the high volume return premium. Although we do not have direct measures of risk aversion differences across countries, we do have measures of investor confidence, which may affect investors' risk aversion. The rationale is that if investors are less confident about a financial system, then they may be more likely to exhibit additional risk aversion in their investment behavior. Based on this assumption, we employ four alternative proxies that can affect investor confidence in a financial system: an accountings standards index, a country credit rating index, an index of country risk, and a measure of whether shortselling is allowed in the country. The accounting standards index, obtained from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998), is a measure of the quality of the information available to investors. It is constructed based on the examination of company reports from different countries in which it is presumed that the higher the index, the better are the accounting standards in that country. Table 2.4 shows that for the countries in our sample the index ranges from 24 to 83, with a mean (median) of 63 (64). The country credit rating index, obtained from Erb, Harvey and Viskanta (1996), is based on a survey by *Institutional Investor* of global bankers' assessments of the country's credit risk. As Erb, Harvey and Viskanta explain, these assessments are based on such factors as political risk, inflation, volatility and controls, the nation's industrial portfolio, economic viability and sensitivity to economic shocks. Across the countries in our sample, Table 2.4 indicates that the index ranges from 21 to 94, with a mean (median) of 60 (64). The country risk index is the International Country Risk Guide (ICRG) index, which is published by the PRS Group, Inc. and which combines ratings of political, economic and financial risks into one measure. The composite score can theoretically vary between zero and 100, but as shown in Table 2.4 the composite scores actually vary between 40 and 94 for our sample, with a mean (median) of 76 (81). The final proxy for aggregate risk aversion in a market is a much coarser measure and consists of a dummy variable for whether short selling is allowed in the country, i.e., whether short selling is legal.

## 2.4. Cross-country Tests of the Determinants of the High Volume Return Premium

In testing the predicted determinants of the high volume return premium across countries, we first conduct univariate tests and then turn to multivariate tests in which we also include control variables.

### 2.4.1. Univariate Tests

To construct the dependent variable, each country's high volume return premium, we form reference return portfolios on the portfolio formation dates as described in Section 2.2. For each of the potential explanatory variables, we divide the country reference return portfolios into two or three groups according to the magnitude of the explanatory variable. We then calculate the average twentieth day reference returns for each group.

Table 2.5 reports the differences in the twentieth day reference returns between the portfolios in the highest and lowest magnitude groups for each of the potential explanatory variables. The table also reports a t-test for those differences. With the exception of the accounting standards index, significant differences exist across the portfolios' twentieth day reference returns, in the predicted direction. The evidence in Table 2.5 indicates that these variables are economically significant in explaining the high volume return premium, with differences ranging in absolute magnitude from 28 to 112 basis points. For example, for countries with a large number of listed companies per capita in urban areas versus countries with a relatively smaller number there is a 48 basis point difference in the returns on their reference portfolios. Similarly there is a 55 basis point difference when the three largest industries dominate the market. Even more striking, as the results for the market value ratio show, when there are very large firms in a market relative to smaller firms, there is more than a 100 basis point difference in the reference portfolios' $20^{th}$ day returns.

Examining the results for each variable individually, we find that countries with more listed companies per urban population show greater high volume return premiums. Such a result is consistent with the implications derived in the previous section. When a country has more listed companies, the investor base for each of the companies individually would be expected to be lower, allowing for a larger effect from a visibility shock. The results for the second demographic variable show that the more educated and sophisticated the investors in a country, as reflected in the secondary school enrollment variable, the more informed, in general, these investors would be about stocks, suggesting that they are less likely to trade on a stock's increased visibility. Thus, the lower is the high volume return premium.

The two measures of market concentration have a positive association with the high volume return premium as implied by the investor recognition hypothesis. That is, countries with a larger market value ratio (i.e., greater range of firm sizes) and countries in which the largest three industries are more dominant exhibit a greater return to increased visibility from a volume shock.

The $R^2$ measure exhibits a significant positive relation with the high volume return premium, consistent with the hypothesis that countries in which stocks have less firm-specific information in their prices relative to market-wide information, the greater the effect of a movement that captures investors' awareness.

Three of the four investor confidence measures, the country credit rating index, the ICRG index, and the short selling measure, exhibit significant differences across the high volume return premium portfolios. The higher country credit ratings and the higher ICRG (potentially suggesting less risk aversion among investors) are associated with smaller high volume return premiums.

The univariate results show that, in general, when portfolios are formed around each of the variables individually, there tend to be significant differences in the 20th day reference returns between country portfolios that are in the top-third group versus the bottom-third group according to each variable.[17] These results suggest that differences across countries in the high volume return premium can be explained by differences in the demographic, market characteristics and investor confidence variables that serve as proxies for differences across investor bases in the securities.

[17] We find essentially the same results when we use the zero investment portfolio returns rather than the reference return portfolio returns.

### 2.4.2. Multivariate Fama-MacBeth Tests

In this section we conduct tests of the cross-country determinants of investor visibility events using multivariate Fama-MacBeth tests in which we run a series of cross-sectional regressions for each interval from 1988 through 2000. The dependent variable in these regressions is the 20th day return on the high and low extreme volume stocks. The independent variables are the country characteristics hypothesized to be related to the investor visibility event, the high volume return premium. We also employ variables to control for market development, market liquidity, firm size, country legal origins, average market risk, and the difference between high and low extreme volume shocks.

Given the differences in reference return portfolio returns between the developed and the emerging markets found in Section 2.2, we also designate countries as being in one of three groups based on market development: the most developed markets (G-7 countries), the other developed markets, and emerging markets. We then control for market development through two dummy variables representing the extremes of development: G-7 countries and emerging market countries.

A potential alternative explanation for the investor visibility event effects we have found is that the effects are driven by changes in the stock's liquidity rather than a change in visibility Amihud and Mendelson (1986) provide evidence that stocks can carry a liquidity premium. Gervais, Kaniel and Mingelgrin (2001) test whether such a liquidity premium can explain the high volume return premium they found in the United States market. They provide evidence against this potential explanation. If despite their results, the high volume return premium should reflect changes in liquidity (rather than an investor recognition effect), then the implication is that each stock has a time-varying liquidity component and that the rates of changes in liquidity systematically vary across countries. To check for this effect, we include a measure of the liquidity of the country's stock market in our regressions. As we do not have average bid-ask spread measures for the various countries, we proxy market liquidity by the market turnover ratio, defined as the total value of shares traded divided by average market capitalization.

Merton (1987) suggests that the magnitude of a stock's response to an increased visibility event will be greater for firms with a smaller investor base, which could be associated with firm size. To measure this potential effect and to control for any relations between volume and firm size (e.g., Blume, Easley and O'Hara, 1994), we construct size portfolios based on the stock's market capitalization for the stock at the previous year-end. Ideally we would construct three size portfolios for each country, however, some countries have a relatively small number of securities. Thus, we group the stocks in a country into one, two or three size portfolios depending on the number of stocks traded and the range of market capitalizations. The algorithm is as follows. We divide the country's stocks into deciles based on market capitalization and compare the median market capitalization of the largest market capitalization decile to the second smallest market capitalization decile. If this ratio is greater than 500 and there are more than 400 securities trading in the market, then we divide the market into three size portfolios. If the ratio of median market capitalization for the largest versus second smallest decile is greater than 100, and there are between 100 and 400 securities trading in the market, or if the ratio is less than 100, but there are more than 250 securities trading, then the market is divided into two size portfolios. In all other cases, the market is not divided into size portfolios.

We also include a control for a country's legal origin in order to separate out investor confidence from the country's legal system. The measures of legal origin are dummy variables indicating the origin of the country's legal system: Scandinavian law, French law, German law, with the omitted variable being English law. These measures are obtained from La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998). Poland and China are eliminated from this analysis because they do not fit into one of these four regimes.

Earlier we tested for whether the return differences between the high and low volume stocks could be due to differences in their systematic risks. We did not find evidence supporting such a hypothesis. The possibility remains, however, that differences in the high volume return premium across countries is due to differences in risk in general across the countries. Thus, we control for the general risk in a country's equity markets in order to ensure that differences in risk across countries are not explaining the differences in returns on the country portfolios. Our measure of overall market risk is the average volatility of the return on the stocks traded in the market.

We expect that many of our explanatory variables are related to each other. For example, Eleswarapu and Venkataraman (2003) document a relation between a market's trading costs and measures of investor confidence, which would imply a relation between our liquidity measure and the measures of investor confidence. To check for cross-variable relations, in Table 2.6 we provide a correlation table for our explanatory variables. Not surprisingly, the emerging market indicator is negatively correlated with the two demographic variables and the three investor confidence variables. However, it does not exhibit meaningful correlation with any of the market characteristic variables. The two measures of concentration are somewhat correlated, implying that markets that are dominated by a few industries also have some tendency to be dominated by larger companies. The other strong correlations are between the investor confidence variables and the demographic variables. For example, countries with higher secondary school enrollments tend to have higher levels of investor confidence. Given the strong correlations among the investor confidence variables and between the investor confidence variables and other variables, in our multinomial regressions of the high volume return premium on the explanatory variables, we include the investor confidence proxies separately in the regressions.[18]

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[18] We also ran a regression without any investor confidence proxy included and found that our results on the other variables did not materially change.

The results from the multivariate regressions and the Fama-MacBeth procedure are presented in Table 2.7. The results from all of the models are generally consistent with the predictions we derived from the investor recognition hypothesis for how the high volume return premium should vary across countries with different demographic and market characteristics.

We find that the high volume return premium is increasing in the number of listed companies per million urban people, which suggests that the more stocks in the country per potential available investor, the greater the effect of changed visibility. On the other hand, there is no apparent effect of the country's education level, once other factors are considered. This result may be due to the crude proxy we are using for investor education.

The high volume return premium is increasing in both measures of market concentration, the market value ratio and the domination of certain industries, consistent with the implication that with greater market concentration investors focus on the dominant stocks (whether because of size or industry). Thus, changed visibility becomes more important in making individual investors aware of the other stocks.

In terms of incorporated information in stock prices, again we find that countries with higher $R^{2}$'s have larger high volume return premiums. We interpret this result as implying that when there is less firm-specific information in stock prices, there is a greater likelihood of a visibility event impacting prices. We discuss alternative potential explanations for this variable later in this section.

The investor confidence measure that was not significant in the univariate tests, the accounting standards index, is now significant after controlling for other factors. This result implies that markets in which investors have less confidence due to less adequate accounting standards have larger high volume return premiums. This result suggests that controlling for other differences, investors in such markets are more susceptible to changes in a stock's visibility because they put less credence in the accounting information available regarding the stock. If one also interprets the country's accounting standards index as reflecting the amount of firm-specific information incorporated into the country's stock, then the coefficient on this variable is consistent with the coefficient on the $R^2$ variable.

Two of the three other investor confidence proxies also show a significant relation with the high volume return premium, the country credit rating and the ICRG index. The short selling proxy no longer has a significant relation with the high volume return premium, once other factors are controlled for, however, this lack of significance may simply be a manifestation of the high negative correlation between the emerging market dummy and the allowance of short selling, since many emerging markets did not allow short selling during our sample.

In terms of market development, the different models show that emerging market countries are no different in their high volume return premiums than are developed countries that are not in the G-7, except when we control for the legality of short selling in a country. This result may again be affected by the correlation between the emerging market dummy and the legality of short selling in a country. However, the positive coefficient on the G-7 variable suggests stocks in a G-7 country are more susceptible to the effects of an extreme volume shock, ceteris paribus, which may reflect the relatively greater proportion of individual investors in these markets who would be susceptible to investor visibility shocks.

The regressions in Table 2.7 indicate no significant relation between the high volume return premium and our proxy for liquidity, the equity market turnover ratio. Thus, these results do not support the hypothesis that the high volume return premium is due to changes in liquidity from the volume shock. We would not have expected changes in liquidity to explain the magnitude of the high volume return premium because such an explanation would require very strong conditions. First, our methodology implies that stocks get selected to be in the high volume return premium portfolio twenty percent of the time independent of whether the stock was chosen in an adjacent interval or not, which implies a large number of liquidity changes. Second, variations in liquidity would have to differ systematically across countries.

As would be expected from Merton's (1987) argument that firm size (as a proxy for investor base) is a factor in the magnitude of the effect from a visibility event, we find that small firms have significantly higher returns for extreme volume shocks than do medium or large firms. Further, medium size firms have greater returns for extreme volume shocks than do the large firms.

We find that a country's legal origin is not a significant factor in the effects of a visibility event. Thus, if legal origins represent the protection of property rights as suggested by La Porta, et. al. (1998), these protections do not affect investors' response to changes in visibility. This result also has implications for the interpretation of $R^2$ in our regression model. Morck, Yeung and Yu (2000) argue that $R^2$, or stock price synchronocity, can reflect poor and uncertain protection of private property rights in countries. That is, the lack of property rights protection makes informed risk arbitrage unattractive, which increases market-wide noise trader risk. They argue further that the poor property rights protection can also imply that firm-specific information is less useful to risk arbitrageurs, leading to less capitalization of that information into stock prices. Both of these interpretations of the implications of $R^2$ would also be consistent with higher volume allowing investors to become more aware of individual stocks. However, our results regarding legal origins suggest that the poor protection of property rights is not the cause of the value of increased visibility.

The coefficient on market variance is not significant suggesting that total risk is not an explanation for differences in the high volume return premium across countries. This result is consistent with the earlier result that differences in systematic risk do not explain the high volume return premium.

To test the robustness of our results to alternative model specifications, we also ran a fixed-effects pooled regression model using all of the individual observations. The results of this regression are consistent with those of the Fama-MacBeth regression approach shown in Table 2.7. Due to the conservatism of the Fama-MacBeth approach, we have chosen to present only those results.

### 2.5. Foreign Investors, Financial Liberalizations, and the High Volume Return Premium

For many of the stock markets in our sample, including most of the emerging markets, the presence of foreign investors has been growing over the sample period. This growth has two potential effects on our analysis. First, the financial liberalizations occurring over the last two decades could affect our analyses, causing inappropriate inferences. Second, the presence of foreign investors could have an effect, or a changing effect, on the high volume return premium. In this section we discuss these two possible effects and their implications for our analyses.

During our sample period, some of the markets in our sample went through financial liberalization processes, which further opened the markets to foreign investors. Besides increasing the presence of foreign investors in the markets, Bekaert, Harvey and Lumsdaine (2002a) argue that the financial liberalizations create a nonstationarity in portfolio flow data. This nonstationarity in portfolio flows could potentially lead to differences in the high volume return premium over time. There are a couple of factors that would mitigate this potential problem. First, most of our data for emerging markets begins after the major financial liberalizations as described in Henry (2000) or Bekaert and Harvey (2000) or the market integration as described in Bekaert, Harvey and Lumsdaine (2002b). Second, due to the short intervals we are employing (seventy day periods), the structure of our tests should not be affected by the increased portfolio flows. That is, we are testing over such short periods that changes caused by increased foreign investor flows (or decreased flows in the case of a financial crisis) should not affect our results.

The presence of foreign investors in a market can potentially affect the visibility of stocks in the market and the importance of that visibility. Because of the information asymmetry between foreign and domestic investors, a stock's visibility may become more important in markets that have a strong foreign investor presence. Consistent with this hypothesis are empirical studies by Kang and Stulz (1997) and by Dahlquist and Robertsson (2001).[19] Kang and Stulz find that foreign investors in Japan tend to hold more stocks that have characteristics of higher visibility – they tend to hold shares of larger firms and of firms with significant export sales. Similarly, Dahlquist and Robertsson find that foreign investors in Sweden tend to hold firms with a greater presence in international markets, even after controlling for firm size. Given this empirical evidence regarding the preferences of foreign investors for more visible stocks and the increasing presence of foreign investors in financial markets, the question arises as to whether the high volume return premium increases in foreign investor presence.

Both the increased presence of foreign investors and the possible nonstationarity of portfolio flows potentially imply time-varying changes in the

[19] The results of Foerster and Karolyi (1999) for foreign firms which start trading ADR's are also consistent with these studies.

high volume return premium. We conduct several tests to explore whether these factors affect our empirical analysis. In the first test, we divide our sample into two subperiods and run our tests across the subperiods. Other than reducing the power of our tests due to the smaller number of observations in each subsample, we do not find substantial differences across time, suggesting that neither increased foreign investor presence nor nonstationarity change our central results. In the second test, we focus on the seven countries that had financial liberalizations during the sample period. For these countries, we test for differences in the high volume return premium across the pre-liberalization and post-liberalization periods. We find significant high volume return premiums for the countries both pre- and post-liberalization, and no significant differences between the two.

In the third test, since most foreign investors are institutional investors, we used institutional holdings data for the United States to examine the effects of institutional investors on the high volume return premium. For all firms with securities listed on the New York Stock Exchange (NYSE) we gather institutional holdings (from the CDA Spectrum 13F filings database).[20] Because of the strong correlation between institutional holdings and market capitalization (Sias and Starks (1997)), we sort the sample firms into three size groups based on market capitalization. Within each size group we then sort by institutional holdings. We construct the reference return portfolios in the same manner as in Section 2.2, except that we divide the portfolios by firm size and

[20] Institutional investment managers with $100 million or more in equity securities under management are required to file 13F reports on a quarterly basis.

institutional holdings. The results for the 20th day average returns indicate that in general there is a significant difference in the high volume return premium across levels of institutional holdings. That is, firms with low institutional holdings have a greater high volume return premium than do firms with large institutional holdings, suggesting that the visibility created by volume shocks is more important when there are fewer institutional investors interested in a firm. This result is consistent with the investor recognition hypothesis in that the visibility is most important for the individual investors rather than the institutional investors. The result on institutional holdings also suggests that the increase in foreign institutional investors should not heighten the high volume return premium in a country. In summary, all three of our additional tests indicate that the increased presence of foreign institutional investors should not significantly alter our results or conclusions.

**2.6. Conclusion**

In this paper we examine a visibility event and whether the event's effects are related to characteristics of markets as would be implied by Merton's (1987) investor recognition hypothesis. Using the Gervais, Kaniel Mingelgrin (2001) high volume return premium as our measure of a visibility event and its effects, we study the existence and magnitude of this premium across equity markets in 41 different countries and find that it is a strikingly pervasive global phenomenon. We find evidence that the high volume return premium is a significant presence in almost all developed markets and in a majority of the emerging markets as well. The premium varies in magnitude across the markets and we provide evidence that the variation is systematic in ways predicted by the investor recognition hypothesis. We find that characteristics of the market affect the high volume return premium, generally consistent with the hypothesis. The most significant determinants are proxies for the investor base, including investor demographics and a market's information dissemination, the investor confidence in the country's markets, and the size of the company.

We also find that the high volume return premium is not related to liquidity changes in the stock. This is not surprising as the ability of liquidity changes to explain our results would require a very high time-variation in liquidity that exhibits systematic differences across countries.

Our results are consistent with previous studies which show that investor stock visibility events can have significant return effects. Our results, however, are unique in that we examine an event across countries, while the previous studies have focused within a particular country. By examining the visibility event across countries, we are also able to provide insights into what factors affect the magnitude of the return effects from the visibility event.

Our study underscores the importance of volume in asset pricing and provides an impetus for further research into the effects of volume and changes in volume. A better understanding of the role of volume can be obtained from further examinations of volume in other markets, not only stock markets with differences in characteristics and fundamentals, but also other types of asset markets such as derivative markets. Our results suggest that volume is important to investors' decision-making processes, which underscores the importance of volume in any theory of asset pricing. Most importantly there is need for additional self-consistent theory of the role of volume.

# Chapter 3

# Is Liquidity Risk a Common Risk Factor? International Evidence

## 3.1 Introduction

Liquidity has long been considered as an important aspect of stocks' risks. Intuitively, investors bearing risks associated with illiquid stocks should be compensated with higher expected returns. In the literature, numerous studies have investigated the relationship between liquidity and expected stock returns.[21] Using various liquidity measures, these studies generally find that on average less liquid stocks have higher returns. A recent study by Pastor and Stambaugh (2003) has gone beyond investigating liquidity as a stock's characteristic relevant for pricing. Instead, they show that expected stock returns are related to the sensitivities of returns to fluctuations in aggregate liquidity. In other words, market-wide liquidity is found to be a state variable and is indeed priced. Using their sample of U.S. stocks during 1966 to 1999, they find that stocks with higher sensitivity to aggregate liquidity have substantially higher expected returns, even after accounting for market, size,

[21] Studies have empirically investigated the relation between liquidity per se and expected stock returns include Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Brennan, Chordia, and Subrahmanyam (1998), Datar, Naik, and Radcliffe (1998), and Fiori (2000).

value, and momentum factors. The purpose of this chapter is to explore whether systematic liquidity risk is priced in international equity markets. The motivation of this study is straightforward: if market-wide liquidity is a common risk factor, it should not be sample-specific but should be priced in international markets as well.

In this study, we empirically test whether liquidity risk is priced in the stock markets of 19 developed countries. The main finding of our analysis is that liquidity risk is indeed priced in stock markets outside the U.S. In a number of international markets, the average return on stocks with higher sensitivity to market liquidity exceeds that for stocks with low sensitivities significantly, both in economic terms and statistically, adjusted for other asset-pricing factors. In addition, consistent to evidence supporting other factors, such as the market return, size and value factors, to be risk factors, we find that the market liquidity seems to have reasonable predictive power for future economic growth. Therefore, our out-of-sample analysis favors a risk-based explanation to stock's liquidity premium.

This chapter contributes to the literature in the following three ways. First, it is, to our knowledge, the first study that attempts to calculate a market liquidity measure for a large set of international markets based on a theoretical ground, which is the principle that order flow induces greater return reversals when liquidity is lower (Campbell, Grossman, and Wang 1993). Second, it is also the first one to investigate systematic liquidity risk using the standard multi-factor model in such a broad international setting. Compared with the tremendous effort put into the liquidity of the U.S. market, only a few studies in the literature attempt to study liquidity in stock markets abroad.[22] Third, when researchers do study international liquidity, most of them focus on a single international stock market, with the exceptions of Bekaert, Harbey and Lundblad(2003), and Domowitz, Glen and Madhavan (2001). Therefore, the methodology we take enables us to directly compare the results for international markets with those well documented by Pastor and Stambaugh (2003) for the U.S.

The remainder of the chapter proceeds as follows. Section 3.2 reviews previous literature on the interrelationship between liquidity and asset pricing. Section 3.3 describes the sample selection process and some summary statistics of the data.  Section 3.4 describes how we construct the liquidity measure and the empirical features of the measure. Section 3.5 focuses on the core question of whether market liquidity is priced in international markets by testing whether the abnormal returns ("alphas") are significantly different from zero. Section 3.6 provides additional evidence of a risk-based explanation for the liquidity premium by showing that market liquidity predicts future economic growth. Section 3.7 concludes.

[22] Giouvris (2002) studies the systematic liquidity as firm-specific variability in liquidity in London Stock Exchange. Martinez et al. (2003) study two measures of the market-wide liquidity factor, including the one developed by Pastor and Stambaugh (2003) in the Spanish stock market. They show that neither of these proxies for systematic liquidity risk carries a premium with their sample.

### 3.2 Literature Review

This section provides a detailed review of the literature on stock's liquidity. It is important to distinguish between liquidity per se and liquidity risk of assets. It is fair to generalize that in earlier literature all attention is paid to liquidity as a characteristic of stocks, i.e. liquidity per se. In recent years, it has been recognized that liquidity may have some common components and may serve as a risk factor.

Liquidity is an elusive concept. It is not directly observable but rather has a number of aspects that are difficult to be captured by a single measure. Financial economists typically follow Grossman and Miller's (1988) notion that liquidity refers to the ability to trade large quantities quickly, at low transaction cost, and without moving the price. Along this line, earlier research, most of which exists in the market microstructure literature, focuses on studying liquidity as a firm-specific attribute, and seeks to determine whether low-liquidity stocks earn higher expected returns. The measures commonly adopted to proxy for liquidity are largely high-frequency, often times intra-daily data at the transaction level, including bid-ask spread, trading volume, quoted order size, or some variations or combinations of those variables together with stock price and/or return. Classic examples are papers by Amihud and Mendelson (1986) and Brennan and Subrahmanyam (1996). Amihud and Mendelson (1986) empirically demonstrate that asset returns are increasing in the cost of transaction (bid-ask spread) and hypothesize that in equilibrium, assets with higher bid-ask spreads will be held by investors with longer investment time horizons. Brennan and Subramanyam (1996) take an innovative approach and decompose transaction costs into variable and fixed components. They find a significant relationship between required rates of return and measures of illiquidity, after adjusting for the Fama and French risk factors and the stock price level.

In contrast to liquidity per se of stocks, there is a concept of *liquidity risk*. To study liquidity as a risk factor, it is implied that there is a systematic or market-wide component in liquidity. In fact, only a few recent studies investigate the issue of a systematic component of liquidity. Chordia, Roll, and Subramanyam (2000) estimate a “market model” for liquidity, which is to regress daily percentage changes in liquidity variables for individual stocks on the market averages of the same variables. They find the resulting “betas” to be positive for 85% of all stocks in their sample, and almost 42% exceed the 5% one-side critical value. Their results remain robust after controlling for popular individual liquidity determinants such as volatility, volume, and price. Huberman and Halka (2001) document the presence of a systematic, time-varying component of liquidity using four proxies of liquidity. Moreover, they find that the temporal variation in the liquidity proxies is positively correlated with return and negatively related with volatility. Hasbrouck and Seppi (2001) adopt principal components and canonical correlation analyses to identify common factors in the time variation of several liquidity proxies for the 30 stocks in the Dow Jones Industrial Average. However, they do not find any strong relation between common liquidity factors and returns and their results appear to be vulnerable to the ordering of the explanatory variables in the regressions employed each time.

From an asset-pricing point of view, only undiversifiable risk should be priced. Pastor and Stambaugh (2003) create a measure of aggregate liquidity and demonstrate that stocks that highly covary with this aggregate liquidity measure exhibit higher expected returns than stocks whose returns have low covariation with aggregate liquidity. As they discuss in the paper, when investors face an economic recession and thus their overall wealth decreases, they may be forced to liquidate some assets to raise cash. But unfortunately, such liquidation is relatively more costly when liquidity is lower, particularly when wealth has dropped and marginal utility is higher. Moreover, these effects will be even more pronounced if investors have to liquidate assets that react strongly to changes in market-wide liquidity. Therefore, investors will require a systematic liquidity premium to hold such highly sensitive assets. Using the sample of U.S. stocks from 1966 to 1999, they show that a spread between the top and bottom deciles of predicted liquidity betas generates an abnormal return of 7.5% annually adjusted for exposures to four commonly used factors: the market, size, value and a momentum factor.

Acharya and Pedersen (2004) develop a stylized model that leads to three different risk premia associated with changes in liquidity, and empirically find these risk premia to be highly significant in U.S. data. Specifically, they form 25 portfolios sorted on the basis of the previous year's liquidity level, not Pastor and Stambaugh's regression coefficient of return on market liquidity. They find average returns range from 0.48% to 1.10% per month as the illiquidity of the portfolios rises. Their most important effect on the variation in average returns is the covariance of liquidity with market return – the chance the stock may get more illiquid if the market goes down.[23]

Realizing the limitation that current research on liquidity mainly focuses on the United States, arguably the most liquid market in the world, researchers have started looking into other counties' data to study the impact of liquidity on stock returns. Bekaert, Harvey and Lundblad (2003) measure liquidity as the proportion of zero daily returns observed over the relevant month for each of the 19 emerging markets in their sample. By pooling data across those markets and using a structural VAR model, they find their liquidity measure significantly predicts future returns, whereas alternative measures such as turnover do not. Domowitz, Glen and Madhaven (2000) focus on the interactions between trading costs, liquidity, and volatility for many countries.

[23] Liquidity has been extensively studied and modeled in theory. The theoretical literature on liquidity includes Kyle (1985), Glosten and Milgrom (1985), Easley and O'Hara (1987), and Admati and Pfleiderer (1988). Among studies linking liquidity and stock expected returns as well as other variables are Amihud an Mendelson (1996), Constantinides (1986), Grossman and Miller (1988), Heaton and Lucas (1996), Vayanos (1998), Lo, Mamaysky and Wang (2004), Holmstrom and Tirole (2002), Huang (2003), Eisfeldt (2004), and Easley, O'Hara, and Hvidjkaer (2002).

To study those interactions, they are forced to utilize trade level data, provided by Elkins/McSherry Inc., however, only over a two-year period. They also use their panel data to investigate the impact of trading costs, liquidity and volatility on equity returns. They show that increased volatility, acting through costs, reduced a portfolio's return. At the same time, higher volatility reduces turnover, also mitigating the impact of higher costs on returns.

### 3.3 Sample Selection and Summary Statistics

In this study, we use data from Datastream International and CRSP. Specifically, we employ the daily and monthly data on stocks from 19 developed markets. The variables include daily price, end-of-month price, trading volume, price-to-book ratio, the local return index, and market capitalization of common stocks in those countries. Following the convention of this type of study, we exclude preferred stocks, warrants, unit trusts, and cross listings from the sample. To control for survival bias, we include both currently listed and delisted stocks. Given trading volume is an important variable in this analysis and different exchanges within each country may have different trading mechanisms, which would make aggregating stocks across different trading mechanisms problematic, we only select the stocks traded on the largest stock exchange in each particular country. Further, to avoid the volatility caused by the "penny stocks", we exclude stocks whose prices fall below the 5 percentile of the price range of each country. Whenever country market indices are needed, we use the Datastream value-weighted market index.

The ending dates are the same for all countries in our sample, which is June 2001. But due to the difference in the starting dates, the sample length varies across different countries. Table 3.1 reports the starting dates for each country. The U.S. sample is available from 1962, and the Canada sample starts from 1973. The rest of the countries start from early 80's to early 90's.

Table 3.1 also displays the average number of qualified stocks across months for each country. It shows that the U.S. is not the only highly populated market. Japan and the United Kingdom respectively have 1297, 590 stocks on average in the sample period. Canada on average has 399 stocks each month partly due to the longer history it has in the database and the availability of relatively fewer stocks in the earlier period. To present the dispersion of the number of eligible stocks, we also report the minimum and maximum numbers of stocks in each country. Some countries, such as Belgium, Denmark, New Zealand, and Switzerland have fewer than a couple of dozen stocks in some months. Therefore, the results for those countries should be interpreted with caution.

### 3.4 Market-Wide Liquidity

In this section, we create a market-wide liquidity measure following Pastor and Stambaugh (2003) for each country in our sample. We then study the market-wide liquidity measure within each country and across countries. We also examine the relation of the market liquidity measure with other variables used in the asset-pricing literature.

### 3.4.1 Methodology

As discussed in the literature review above, researchers have used a number of market-structure based, in many cases intradaily transaction-level, variables to measure liquidity. In our context, we are more interested in stocks' sensitivity to shocks in market-wide liquidity. Therefore, we adopt the measure created by Pastor and Stambaugh (2003) that is to measure the market-wide liquidity using daily and monthly data.

The basic idea behind Pastor and Stambaugh's measure is that stocks are "illiquid" if there is a large price-impact of "order flows". They construct the "order flow" as trading volume signed by the contemporaneous return on the stock in excess of the market. And they define liquidity for stock $i$ in month $t$ as the ordinary-least-squares (OLS) estimate of $\gamma_{i,t}$ in a regression run over the trading days of the month,

$$r^e_{i,d+1,t} = \theta_{i,t} + \phi_{i,t} r_{i,d,t} + \gamma_{i,t} sign(r^e_{i,d,t}) \cdot v_{i,d,t} + \varepsilon_{i,d+1,t} \qquad (1)$$

Where the variables are defined as follows:

$r_{i,d,t}$ : the return on stock $i$ on day $d$ in month $t$

$r^e_{i,d,t}$ : stock $i$'s excess return, $r_{i,d,t} - r_{m,d,t}$, where $r_{m,d,t}$ is the return on the value-weighted market return on day d in month t, and

$v_{i,d,t}$ : the "dollar" volume for stock $i$ on day $d$ in month $t$. Throughout the paper, the "dollar" volume refers to the product of a stock's trading volume and its price in its local currency.

For a stock in a given month, only if there are at least 14 observations,[24] not necessarily consecutive, we run the above regression to estimate $\gamma_{i,t}$.

To further understand the measure $\gamma_{i,t}$, assume there is selling pressure from non-informational investors or liquidity-motivated investors. The risk-averse market maker needs to accommodate this desire to sell, however, by lowering the price at which he is willing to buy. Similarly, when there exists buying pressure from non-informational investors, the market maker tries to accommodate such demand by increasing the price at which he is willing to sell. To provide this liquidity service, the market maker is compensated with higher expected return. That volume-related return reversal is precisely what is modeled by Campbell, Grossman, and Wang (1993). Therefore, $\gamma_{i,t}$ is largely expected to be negative. It turns out that the estimates of the liquidity measure

[24] Pastor and Stambaugh (2003) require 15 available observations each month for their U.S. study. We find that if we apply the same restriction the results are essentially the same. We choose to use 14 observations as we are left with more stocks each month.

$\gamma_{i,t}$ are indeed mostly negative for the U.S. market. Moreover, it is also the case with the 14 international markets in our sample.

After the individual coefficients have been estimated for each stock and each month in each country of our sample, we construct the market liquidity in month $t$ by averaging those coefficients across different stocks:

$$\hat{\gamma}_t = \frac{1}{N_t}\sum_{i=1}^{N} \hat{\gamma}_{i,t} . \tag{2}$$

As the goal is to examine the returns and unanticipated innovations in liquidity, we construct the innovations following Pastor and Stambaugh (2003):

$$\Delta\hat{\gamma}_t = \left(\frac{m_t}{m_1}\right)\frac{1}{N_t}\sum_{i=1}^{N}(\hat{\gamma}_{i,t} - \hat{\gamma}_{i,t-1}) \tag{3}$$

where $m_t$ is the market capitalization of the stocks included in the average in local currency at the end of month $t-1$, and the scaling factor $\frac{m_t}{m_1}$ should remove the effect of the growing size of the market on the market liquidity measure.

Then we regress $\Delta\hat{\gamma}_t$ on its lag and the lagged value of the scaled series constructed in (2):

$$\Delta\hat{\gamma}_t = a + b\Delta\hat{\gamma}_{t-1} + c\left(\frac{m_{t-1}}{m_1}\right)\hat{\gamma}_{i,t-1} + u_t .$$

For the U.S. market, they take $L_t = \frac{1}{100}\hat{u}_t$ as the “market liquidity”. For each international market, the fitted residual is scaled by a factor from $10^2$ to $10^9$ to obtain more convenient magnitudes for the market-wide liquidity factor.

### 3.4.2 Empirical Features of the Liquidity Measure

Table 3.2 summarizes the market-wide liquidity measure for each of the markets in our sample. We observe the following three features of the market-wide liquidity series for these 19 countries. First, the market liquidity measure is pervasively negative for 15 countries, and 13 of them are statistically significant from zero, including the U.S.[25] This feature is consistent with the implications of its design, where liquidity is measured by the extent of the return reversal resulting from an order flow. Second, the first-order serial correlation is positive for 15 countries, and 10 of them are statistically significant. This is also consistent with the results for the U.S., i.e. a drop (rise) in market liquidity tends to be followed by a similar movement the next trading day. Third, the countries with market liquidity measures that are statistically significantly negative and/or significantly positively auto-correlated are usually those with relatively large number of stocks in the cross-section. This indicates that the sample size of each country might impact the results to some extent.

[25] The results for the U.S. are all replicated following Pastor and Stambaugh (2003) by the author.

### 3.4.3 The Liquidity Measure across Countries

Financial economists are interested in studying the correlation of a specific measure across international markets. Since measures such as book-to-market ratio, earnings-price ratio, and cash-flow-to-price ratio become popular in explaining the cross-section of expected return, researchers have tried to see whether these measures are correlated across international markets. Under the assumption of integrated international markets, significant correlation of a particular measure across markets, like that of the market risk factor that has been widely documented, would lend support to the claim of that factor being a risk-based factor. The correlation of the market liquidity across markets is relatively in the low end, around 0.08 on average. But it is difficult to tell whether the low correlation is driven by the high volatility of the international stock market data. We will carry out more analysis in the next two sections before we draw any conclusion on whether liquidity is a risk factor.

### 3.4.4 Correlations of Liquidity and Other Factors

Within each country, it is also important to examine the correlations of the market liquidity with market return and other commonly used factors in the empirical asset-pricing literature. Those factors are $SMB$ and $HML$, the size and value factors constructed by Fama-French (1993), and a momentum factor, $WML$[26], motivated by Jegadeesh and Titman (1993) and Carhart (1997).

#### 3.4.4.1 A Word on International $SMB$, $HML$ and $WML$

This analysis requires data on the Fama-French factors and a momentum factor, $WML$ for the international markets. However, data on factors $SMB$ and $WML$ are not readily available for these international markets. Only data on $HML$ for the sample countries can be found at the website created by Kenneth French.[27] Therefore, recognizing the international data at hand have no bias of any sort that we are aware of, we construct the factors $SMB$, $HML$ and $WML$ for those countries on our own.

As a check to the quality of the factors we create, we compare our $HML$ of each country with that provided by French. Although French's factor uses raw data from a different source, Morgan Stanley Capital International (MSCI), the distributional characteristics of the two $HML$ series are very similar for every country. The correlations between our constructed $HML$ factor and French's are above 94% in all countries. With such high correlations, it is not surprising that we verify the pervasive value premium across international markets that Fama and French (1998) document using the MSCI data.

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[26] $WML$ (winners minus losers) is the return to long-short portfolio constructed using past return information.

[27] The $HML$ data on international markets as well as data on all four factors for the U.S. are kindly provided by Kenneth French at the following link: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Moreover, we confirm the profitability of the international momentum strategy that has been reported in the literature (Rouwenhorst, 1998; Liew and Vassalou, 2000; Griffin, Ji, and Martin, 2003). We also prove the existence of a size premium in some countries, but it is also consistent with the controversial literature in this area (Liew and Vassalou, 2000).

We do not report the results of those international factors as they serve as "inputs" to our analysis, rather than being any output.

#### 3.4.4.2 Correlations of Liquidity and Other Factors

Table 3.3 reports the correlation matrix of the innovation in liquidity ($L_t$), the return on the value-weighted market index (Market), $SMB$, $HML$ and $WML$ for each country. The monthly innovation in liquidity, $L_t$, is positively correlated with the value-weighted market return in 15 countries. 10 of them are also statistically significant at 5% level. The direction of this result is the same as shown by Chordia, Roll, and Subrahmanyam (2001), who document a positive association between stock returns and changes in other market-wide liquidity measures using daily data. Based on our results, the finding that market liquidity and market return tend to go in the same direction not only holds in the U.S., but also in many other developed markets.

The correlation between $L_t$ and the size factor, $SMB$, is positive in 12 countries, with only 5 of them significant. This indicates that in periods with lower liquidity small stocks tend to underperform large stocks in those markets.

Or in other words, small stocks tend to respond more negatively to drops in market liquidity.

The results on the correlation between $L_t$ and the momentum factor, $WML$, are very mixed. In most countries, they are not correlated with each other.

#### 3.4.4.3 Test of the International "Flight to Quality" Effect

Although there is a lack of correlation of the market liquidity measure across countries, we find that in general in months when there is a huge drop in liquidity in the U.S. market, as pointed out in Figure 3.1, there is also a drop in liquidity in many international markets. This is not surprising given that in many cases the huge drop in liquidity in the U.S. is caused by events that also have global impact, such as the oil embargo in November 1973, the stock market crash in October 1987, the full blow of the Asian financial crisis to the stock markets in October 1997, and the Long-Term Capital Management collapse in September 1998. Pastor and Stambaugh (2003) note a kind of "flight to quality" effect during those periods in the U.S. financial markets. They present that the correlations between stock returns and three fixed-income variables are significantly negative during months of large liquidity drops, in contrast to the correlations during the remaining months.

In our analysis, we explore whether there exists some sort of "flight to quality" effect in international markets. Instead of replicating Pastor and

Stambaugh (2003) on a country-by-country basis, which involves collecting data on the rate change in the short-term government bills and the returns on long-term government bonds and corporate bonds for each country, we take a different approach. Specifically, we use the "TIC" data released by the U.S. Treasury to test the existence of "flight to quality" effect at the aggregate level. The TIC data, which refers to the data provided by the Treasury International Capital (TIC) reporting system, includes monthly data on foreign transactions in U.S. long-term securities, including Treasury bonds and notes, government corporations and Federal agency bonds, corporate bonds and stocks.[28] Table 3.4 reports correlations between the market liquidity for the U.S. and gross purchases of U.S. government bonds and notes of the 18 foreign countries in our sample. Each of the two series is standardized using its 12-month mean and standard deviation. During the months when liquidity is at least two standard deviations below its mean, the correlations are significantly negative, for the entire sample and the latter half of the sample period.[29] A graphical representation is in Figure 3.2, where the standardized liquidity and gross Treasury purchases are graphed for the 14 low-liquidity months. The downward-sloping regression line indicates a rise in foreign demand for U.S. Treasuries during times of large liquidity drop, reconfirming the negative correlation show in Table 3.4.

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[28] For more information on the TIC data, please go to the Treasury website at: http://www.treasury.gov/tic

[29] The sample for this test starts at Jan. 1977 because the TIC data is not available until after then.

We also implement the same test with government corporations and Federal agency bonds, corporate bonds. The results are weaker although the directions are mostly consistent with that of Treasuries. We do not wish to dig too far into the descriptive analysis of the market liquidity series, as our primary goal is to examine whether liquidity is a source of priced systematic risk in stock returns. We focus on that goal in the next two sections.

## 3.5 Is Liquidity Risk Priced in International Markets?

### 3.5.1 Methodology

In this section, we use the international data to investigate whether a stock's expected return is associated with its return's sensitivity to the innovation in aggregate liquidity $L_t$. Consistent with the sensitivities to other widely used risk factors in the literature, such as the three factors of Fama and French (1993), the sensitivity to $L_t$, denoted by $\beta_i^L$ for stock $i$'s liquidity beta, is defined as the slope coefficient on $L_t$ in a multiple regression where other factors regarded important for asset pricing are controlled for.

Next, for each of the international markets, we adopt a commonly-used portfolio-based approach to study whether the stock's expected return is related to $\beta_i^L$. Specifically, for each country, we create a universe of stocks with sufficiently disperse liquidity betas. At the end of each calendar year, those stocks are sorted by their predicted liquidity betas and form ten portfolios, and returns are calculated for the following 12 months for each of the portfolios. The excess returns on the ten portfolios during the post-formation year are then regressed on factors that are typically considered important in empirical asset pricing studies. If the intercept of the regression is statistically different from zero, then $\beta_i^L$ explains a component of expected returns not captured by exposures to the other factors. If the intercept is statistically indistinguishable from zero, then $\beta_i^L$ explains nothing of expected returns in addition to exposures to other factors.

When we form the portfolios, we estimate $\beta_i^L$ as the coefficient on $L_t$ in a regression with Fama-French three factors as additional variables:

$$r_{i,t} = \beta_i^0 + \beta_i^L L_t + \beta_i^M MKT_t + \beta_i^S SMB_t + \beta_i^H HML_t + \varepsilon_{i,t},$$

where $r_{i,t}$ denotes stock $i$'s excess return, $MKT$ is the excess return on the value-weighted market index of each country, and $SMB$ (small minus big) denotes the return to a portfolio strategy that is long on small market-capitalization stocks and short on big market-capitalization stocks. $HML$ (high minus low) is the return to a long-short portfolio constructed using the book-to-market ratio.

$\beta_i^L$ is allowed to be time-varying. We use the predicted values of $\beta_i^L$ to sort stocks into portfolios. The results for testing whether the risk-adjusted alphas are statistically different from zero are shown in Table 3.7. In a majority of countries in our sample, there exists a large liquidity premium that is independent of other factors.

### 3.5.2 Sorting by Predicted Liquidity Betas

#### 3.5.2.1 Predicting Liquidity Betas

We allow the predicted liquidity beta for each stock, $\beta_i^L$, to depend on the stock's historical liquidity beta as well as a number of other stock characteristics that seem relevant for this purpose and also observable at the time of the portfolio formation. To make our results comparable with those in Pastor and Stambaugh (2003), we use the same set of characteristics to predict $\beta_i^L$. In addition to the stock's historical liquidity beta, the other six variables are: (i) the average value of $\hat{\gamma}_{i,t}$, from months $t-6$ through $t-1$, where $t$ denotes the month when the portfolios are formed, (ii) the natural log of the stock's average traded value in local currency from months $t-6$ through $t-1$, (iii) the cumulative return on the stocks from months $t-6$ through $t-1$, (iv) the standard deviation of the stock's monthly return in local currency from months $t-6$ through $t-1$, (v) the natural log of the price per share from month $t-1$, (vi) the natural log of the number of shares outstanding from month $t-1$.

For each stock at month $t$, we use the most recent five years of monthly data to estimate the coefficients of the historical liquidity beta and the above 6 other variables.[30] Table 3.5 reports those estimated coefficients along with their *t*-statistics. To render a more convenient interpretation for each coefficient, the coefficient reported here is multiplied by the time-series average of the cross-sectional standard deviation of the corresponding de-meaned characteristic. Consistent with the results shown by Pastor and Stambaugh (2003) with the U.S. sample, historical liquidity beta is the most important determinant of the predicted beta among those in the model. In as many as 15 countries, the coefficient on historical beta is positive, and 13 of them are statistically significant. Take Canada for example, the coefficient of 1.10 (*t*-statistic=9.64) on historical beta means that if a stock's historical liquidity beta is one standard deviation above the average of the historical betas of the Canadian stocks in the sample, then the stock's predicted liquidity beta is larger by 1.10 on average over time, when other characteristics are held constant.

Looking at the determinants of the predicted liquidity betas across countries, we find that the coefficient on stock price is significant for 14 international markets in our sample. However, only 8 of them are positively significant, as seen with the U.S. sample, implying that in those markets on average more expensive stocks tend to be more exposed to aggregate liquidity fluctuations. On the other hand, the fact that the coefficient on price is significantly negative for 6 other countries says that price plays a vastly

[30] Please refer to III.A.1. of Pastor and Stambaugh (2003) for the details on how the predicted liquidity beta is obtained.

different role in affecting future liquidity beta in those countries. Similar conclusions can be applied to the coefficient on cumulative return. Not surprisingly, in general, different stock characteristics impact the predicted liquidity betas differently across countries.

#### 3.5.2.2 Post-Ranking Portfolio Betas

For each country, the predicted liquidity beta for each stock is obtained by using the year-end values of the stock's characteristics as well as the estimated coefficients on those characteristics. At the end of each year, stocks are assigned into ten portfolios based on their predicted liquidity betas. The returns over the next 12 months on the ten portfolios are calculated, either equally-weighted or value-weighted. This estimation–prediction–formation procedure is repeated on an annual basis. Eventually we obtain a series of portfolio returns for each liquidity beta decile over the sample years in each country. And those ten portfolio return series are to be used to test whether the risk-adjusted return, "alpha", is statistically different from zero in a regression with commonly used asset pricing factors.

Table 3.6 displays the post-ranking liquidity betas of the ten portfolios for each country. The stocks in each portfolio are value-weighted. (The results for equally-weighted portfolios are not shown, as they are qualitatively identical.) Roughly speaking, the post-ranking liquidity betas increase across deciles and show decent dispersions in almost all markets. This indicates that the seven variables described in section 3.5.2.1, although chosen somewhat arbitrarily, have successfully accomplished the goal of predicting the liquidity beta. It is also fairly impressive to notice that the “10-1” spread, which goes long decile 10 (stocks with high liquidity betas) and short decile 1 (stocks with low liquidity betas), has a liquidity beta that is positive for all countries, with magnitude ranging from 3.23 (Austria) to 8.48 (the U.S.). Nine of those liquidity betas are significant at the 5% level and 1 at the 10% level.

#### 3.5.2.3 Alphas

After we obtain the post-formation returns of the portfolios sorted on liquidity betas for each country, we are ready to test whether the liquidity risk factor is priced in international markets. If the “alpha” is distinguishable from zero in a statistical sense, then the liquidity risk factor is also priced in markets outside of the U.S.

Table 3.7 summarizes the value-weighted portfolios’ post-ranking alphas estimated under three different specifications for each country. One specification uses $MKT$ as the only independent variable. The second one specifies the Fama-French three factors as the independent variables. The third one includes the momentum factor in addition to the Fama-French three factors. The intercept of each specification is referred to as CAPM alpha, Fama-French alpha, and 4-factor alpha, respectively.

For the U.S. market, this exercise verifies the results produced by Pastor and Stambaugh (2003). All three alphas of the 10-1 spread are significantly positive and in the magnitudes comparable to those in Pastor and Stambaugh (2003). For the international markets, Table 3.7 says the liquidity premium is pervasive. It broadly exists in 15 out of 19 countries in our sample. In terms of magnitude, the U.S. liquidity premium is also not unusually large if compared with some other countries. For example, the U.S. 4-factor adjusted liquidity premium is smaller than those of Germany and the U.K. The results for other markets are out-of-sample, so the liquidity premium is not unique to the U.S. sample or the result of data mining.

The liquidity premiums for individual countries in Table 3.7 are of considerable economic significance. However, in most countries, they are not significant relative to their standard errors. Only in five countries, the liquidity premiums are of both economic and statistical significance. That can be attributed to the high volatility of the returns in international markets.

Interestingly, in Australia, Austria, Belgium, and to some extent in Singapore, the liquidity premiums are negative, i.e. stocks with higher sensitivity to liquidity on average earn lower returns. That seems contradictory to the notion that risk taking should be compensated by high return. However, the negative liquidity premium is insignificant in those cases.

### 3.6 The Liquidity Risk Factor and Economic Growth

Economic theories have suggested that there are several channels though which financial market variables can rationally lead changes in real economic activity. Such relation has also been empirically verified. Earlier work on the relation between financial variables and real activity includes Bosworth (1975), Fama (1981, 1990), Geske and Roll (1983), Barro (1990), Schwert (1990), and Lee (1992). Recently there has been renewed interest in studying whether financial variables contain any information on future economic growth. After Fama (1981) documents the presence of a positive and statistically significant relation between the market factor and future economic growth in the U.S., Aylward and Glen (1995) and Mauro (2003) extend his findings to many international markets. A more recent study by Liew and Vassalou (1999) show that a positive and equally strong relation also exists between the performance of $SMB$, $HML$ and future economic growth in a number of countries. In our research on whether market liquidity is a risk factor, it is a natural next step to test the relation between the liquidity factor and future economic growth, which will in turn shed further light on whether market liquidity is a risk-based factor.

Figure 3.1 charts the market liquidity series for the U.S. created in Section 3.4, with the shaded areas representing economic recessions. The recession periods are determined by National Bureau of Economic Research

(NBER) Business Cycle Dating Committee.[31] It appears that during each of the recessions except for the most recent one,[32] the liquidity measure plummets in the earlier period then rebounds, though to different extent, in the latter half of the recession.[33] Motivated by this phenomenon, we compare the market liquidity at different states of future economic growth. We use each country's quarterly year-over-year growth rate in its Gross Domestic Product (GDP) as a measure of economic growth. Also the GDP growth is seasonally adjusted annual rate.[34]

### 3.6.1 Market Liquidity at Different States of the Economy

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[31] The NBER's Business Cycle Dating Committee is the official arbiter of the dates that mark the onset of expansions and contractions in U.S. economic activity—business-cycle troughs and peaks. The NBER does not employ the media's rule of thumb that a recession occurs when gross domestic product (GDP) falls for at least two consecutive quarters. Rather it defines a recession as "a significant decline in activity spread across the economy, lasting more than a few months, visible in industrial production, employment, real income and wholesale-retail sales." This definition makes it clear that the depth, breadth and duration of a downturn are key to determining whether it will be classified as a recession.

[32] It can be argued that the most recent recession is very unique compared with the previous ones. It started from the end of the tech bubble an ended with the shock of "September 11" terrorist attack as well as an unprecedented wave of corporate scandals. Many investors did not realize the bad state of the economy until the recession had started for a while. Those investors' continued frenzy in the stock market could partially explain the relatively high market liquidity during those periods.

[33] But we need to point out that not all periods starting with a drop-off in the liquidity measure followed by a back-up are determined as economic recessions. In this respect, the stock market crash in October 1987 is a perfect example.

[34] The GDP growth rate for each country is from Haver Analytics ®.

For each country, we associate each quarter's market liquidity with the GDP growth 4-quarters ahead.[35] For example, we associate a country's stock market liquidity in Q1 1999 with its GDP growth in Q1 2000. And we sort the GDP growth every quarter. We classify those quarters with the highest 25% GDP growth as "good states" of the economy, and those with the lowest 25% GDP growth as "bad states" of the economy.  We calculate the market liquidity of different states of the economy based on the classification of the GDP growth one year later.

The results are reported in Table 3.8. It shows that the magnitude of the market liquidity, though mostly negative by its theoretical design, is positively related to future economic growth. In other words, higher liquidity in the stock market precedes periods of higher GDP growth. Similarly, poor market liquidity, often signals troubles ahead in economic growth. The difference in market liquidity between good and bad states of the economy is positive in 14 countries and eight of them are statistically significant.

### 3.6.2 Regression Analysis

In this subsection, we examine the relation between market liquidity and future economic growth using regression analysis. We formally implement a similar test as show in Section 3.6.1 with the following regression:

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[35] Our choice of 4 quarters later is kind of arbitrary. The results with 3 or 5 quarters later are similar but marginally weaker. But we do want to allow some reasonable time lag between the liquidity and GDP growth.

$$GDPgrowth_{t+4} = a + b * MarketLiquidity_t + e_t \,, \qquad (4)$$

where $GDPgrowth$ is the year-over-year GDP growth rate four quarters later; $MarketLiquidity$ is the market liquidity at current quarter, and $e$ is the residual term of the regression.

Table 3.9 reports that the slope coefficient in equation (4) for each country, as well as its t-statistic and the goodness-of-fit of the regression, adjusted for the degrees of freedom. It provides evidence that higher market liquidity implies greater economic growth a few quarters later. The interpretation of the slope coefficient is as follows. First recall the liquidity measure can be viewed as an estimate of the liquidity cost, for the average stock, of trading one million stock-market value in the country's local currency, implied by the specification of Equation (1). For example, the average value of the liquidity measure for the U.S. over time is -0.03 (the median is -0.02), indicating that the liquidity cost of trading $1 million market value in 1962 dollars is about 2-3%. The coefficient on $MarketLiquidity$ is 16.5, meaning for 1% decrease in such cost future GDP growth will be 16.5% higher. The relative large magnitude is a reflection of the difficulty associated with reducing the liquidity cost of such a trade even by only 1%. The slope coefficient varies from 0.002 for Italy to 23 for Canada. The large variance is due to the size of the stock market and how much one million local currency units is worth relative to each trade on average.

The analysis in this section demonstrates that the market liquidity has relatively good predictive power for future economic growth. The relation between current market liquidity and future GDP growth is largely positive, and is significant in eight countries.

### 3.7 Conclusion

In this chapter, we implement an out-of-sample analysis on whether market liquidity is a common risk factor. Based on the measure we create for each country, following the idea of Campbell, Grossman, and Wang (1993) and what Pastor and Stambaugh (2003) construct for the U.S. market, we find strong evidence in many international markets that on the cross-section expected stock returns are associated to the sensitivities of stock returns to innovations in market liquidity. In general, stocks with higher sensitivities to market liquidity have significantly higher expected returns, in magnitudes comparable to, in some cases higher than, that of the U.S. market, even after controlling for exposures to the market return, size, value and momentum factors. Therefore, our research lends substantial support to market liquidity being a priced systematic risk.

We compute the liquidity measure proposed by Pastor and Stambaugh (2003) for 18 international stock markets. Consistent with the theoretical design and the results for the U.S., this measure is mostly negative for most of the countries. Moreover, during times when there is a large liquidity drop in the

U.S. market, there is also a similar move in liquidity in other countries. Using the Treasury's TIC data on foreign countries purchases of U.S. Treasuries, we show that there is an effect of "flight to quality" in international markets as well.

One direction for future research is to explore further on the interactions between market liquidity and other factors, such as $SMB$, $HML$ and $WML$. Sadka (2004) applies a form of systematic liquidity to the momentum anomaly and shows that the momentum profits are associated with liquidity risk, and that there exist possible limits to arbitrage due to low levels of liquidity. It would be useful to investigate similar ideas using international data. Research along those lines may be helpful to deepen our understanding and the on-going debate on whether some of the factors mentioned above are risk-based or behavior-oriented.

# Chapter 4

# Using American Depository Receipts to Estimate the Effect of Price Limits

## 4.1 Introduction

Many stock exchanges set up certain limits on the maximum variation that a stock is allowed to have in a single day. Table 4.1 gives an overview of the price limit rules of some of the world exchanges. As reflected in the table, more than half of them have such rules on their national stock exchanges with the intention to control excessive price fluctuation and to foster an orderly market. Whether price limit has such an effect is an unsettled issue. In this study, we investigate what effects the price limits may have on a stock return series. To identify such effects, we use a “natural experiment": we compare the return series of the same stock that is traded on two different exchanges where there are price limits on one exchange but not on the other.

In particular, we use stocks of Japanese companies that are traded both in the U.S. markets in the form of American Depository Receipts (ADRs) and on the Tokyo Stock Exchange (TSE). The shares of a foreign stock that are traded in the United States are called ADRs.[36] There is no daily price limit system in the U.S. stock market, but there are price limits in the Japanese market.

The basic idea of this study is to use the predicted equilibrium prices on limit-hitting days to calculate the moments of the stock returns on those days, assuming that no price limits were in place, and then to compare these moments with the moments of the observed stock returns on the same days. The difference between the predicted moments and the observed moments would be the effect of price limits. The underlying assumption in this paper is that two securities with identical payoffs in all states of the world should sell for the same price barring transaction costs. Therefore, if there are differences between the returns of the two securities - which are claims to essentially identical cash flow stream but are traded on different exchanges, with one exchange subject to price limits and the other not - one could conclude the existence of the effect of price limits.

Clearly, when price limits are hit, the observed return series is not at equilibrium. Price limits have a natural ceiling effect, i.e., they literally limit or prevent stock prices from varying beyond predetermined levels. However, if on the next day the stock price quickly achieves the equilibrium that would have been reached if there were no price limits, the only effect of price limits is to

[36] A comprehensive description of the institutional details about ADRs can be found in Miller (1999).

delay the price discovery process.[37] In this paper, we are interested in another possibility: that price limits may actually change the moments of the return series even after we use the equilibrium price to construct a return series when no ceiling effect is present. In other words, price limits may “cool off" or “heat up" the market (denoted as the C-H effect) by increasing or reducing the magnitude of the first and/or the second moments.

In order to identify the C-H effect, we construct a return series for the equity traded on the home exchange according to Wei and Chiang (2004) and Chung and Gan (2005). Simply speaking, in the newly constructed sample, we replace the returns on limit-hitting days with the average return on the set that includes these same limit-hitting days, as well as the day after. Such constructed returns, denoted as the Wei-Chiang series, after the variance is appropriately taken care of, will only have the C-H effect. There is no ceiling effect in the constructed sample.

The rest of the paper is organized as follows: Section 4.2 reviews previous literature on studying the effect of price limits and on ADRs; Section 4.3 briefly discusses the data; Section 4.4 presents a model of price difference between a home traded stock and its corresponding ADR; Section 4.5 applies the model estimates in Section 4.4 and evaluates the effect of price limits; Section 4.6 offers conclusions.

[37] Brennan (1986) suggests that price limits may also serve as a substitute for the margin requirement.

## 4.2 Literature Review

The literature on price limits can be roughly categorized into two branches: one is interested in identifying whether price limits have any effects on days immediately before and after days that limits are hit. While early literature typically finds a cooling-off effect of price limits, recent empirical work has provided evidence of a heating-up effect of price limits.[38] For example, Kim and Rhee (1997) consider such effects for a sample of Japanese stocks; they find that price volatility levels are higher for the days following limit-hitting days. The other branch of the literature assumes that price limits have no C-H effect and is interested in “recovering" equilibrium return series. It is a typical finding in such literature that different ways of “recovering" equilibrium lead to very different implications. Roll (1986) finds that using different ways to identify equilibrium returns on days that price limits were hit can lead to contradictory conclusions about market efficiency. Wei and Chiang (2004) find that one may underprice warrants by as much as 22% if different measures of the moments of the “recovered" equilibrium returns are used. In addition, George and Hwang (1995) indirectly test the effect of price limits; they argue that price limits in Japan have strong effects on the volatility of stock returns in general, even on days that price limits are not reached.

Previous literature on Depository Receipts has compared either the risk and return of ADRs to those of the home-country equities, or the effects of the

[38] For example, see Ma, Ramesh and Sears (1989).

ADR listings on the home-country equities. For example, Jayaraman, Shastri and Tandon (1993) examine the impact of listing ADRs in the United States on the risk and return of the underlying stock in the home-country market. They find a positive correlation between the listing of ADRs and the return on the securities traded in their home-country markets.

Although we are aware of no previous studies that use Depository Receipts to test the effect of price limits, it is not new to use Depository Receipts as a natural experiment to test financial theories or the effects of financial instruments. For example, Muscarella and Vetsuypens (1996) consider the effect of stock splits using ADRs. The well-documented significant stock price increases around split announcements (and split executions) are generally interpreted as either a market reaction to managers signaling favorable inside information or to better liquidity of the stock due to a more suitable trading range. Typically, when the underlying foreign stock splits in its home market, the ADR also splits in the United States. However, ADRs occasionally split independent of the underlying foreign stock, and these are referred to as solo splits. Muscarella and Vetsuypens (1996) argue that ADR solo splits are unique illustrations of the importance of improved liquidity. They document cross-country differences in trading patterns that explain why liquidity motives would require the splits of ADRs, but not their home-country stocks, and why ADR solo splits cannot be motivated by any explicit managerial desire to signal favorable inside information.

In our study, we use the differences between the returns of the ADR and of its underlying home security on limit-hitting days to detect the effect of price limits. The underlying assumption for this approach is the equivalence at the mean level of returns on two exchanges in the absence of the effect of price limits. The sufficient condition for this assumption to hold is the absence of arbitrage opportunities. Price difference between two exchanges, barring transaction cost, has to be small enough so that no profits can be guaranteed.

The idea of using information other than a directly observed return series has been applied previously in the literature. For example, Kodres (1988) and Kodres (1993) are interested in testing whether currency futures are unbiased estimates of spot price. Since spot price is subject to price limits, a proxy is necessary. She uses the covered interest parity to approximate the spot price for days that limits are hit. The assumption in her study is that no price limit effect itself exists. Our primary interest in this paper is to test whether this assumption is valid.

**4.3 Data**

The price limits utilized by the TSE are reported in Table 4.2. As shown in the table, the size of the daily price limit depends on individual stock price, where the price range refers to the previous day's closing price and is reestablished each day. The price limits are presented in terms of absolute yen as well as a percentage of the price-range midpoint. The same type of information on price variation between two consecutive trades is also given. If a stock's price is between 101 yen and 200 yen, the maximum price variation between trades without trade being halted is 5 yen, and the daily price limit is 50 yen.

To determine whether a stock has reached the price limit, we follow the rule as shown in Kim and Rhee (1997). That is, if the daily high (low) price matches its previous day's closing price plus (minus) the corresponding price limit on a given day, then we assume this as an occurrence of price reaching its limit.

One problem of comparing the stock returns across countries is the differences between trading hours and trading days. In the case of Japan and the United States, Japan is 14 hours ahead of U.S. Eastern Standard Time. On weekdays, the Tokyo Stock Exchange is open from 9:00am to 11:00am and from 12:30pm to 3:00pm local time. This corresponds to 7:00pm to 9:00pm, and 10:30pm to 1:00am Eastern Standard Time. The trading hours on the two markets never overlap.

In order to be included in our sample, a Japanese company must have had its stocks listed as an ADR prior to November 30, 2001. Since we require the opening and closing prices to be available for each of the ADRs (as explained in Section 4.3), we end up with a sample for each stock and its ADR with a starting date no earlier than September 1990.[39] Most importantly, the Japanese stock must have had hit the price limits on the TSE during this sample period. Such screening procedures result in a sample of 25 Japanese stocks that have their respective ADRs traded on the U.S. exchanges, either NYSE or NASDAQ,[40] as ADRs.[41] All price data for each security, opening, closing, daily high and daily low prices, as well as corresponding national market indices, are from the Datastream International database.

It is possible for a stock to hit its price limit more than one consecutive day. Sometimes one stock may hit the upper limit on one day and hit the lower limit the next day. In our sample, there are five stocks that have experienced such situations. In Table 4.3, a single stock on different trading days or different stocks on the same trading days are considered as different trading sessions. The number of total trading sessions, then, equals the $\sum_i^{25} D_i$, where $D_i$ is the trading days of stock $i$. Table 4.3 lists the number of occurrences that price limits were reached consecutively for $k$ days, while $k = 0, ..., K$ and $K$ is maximum days that price limits were hit consecutively. In Table 4.3, we calculate the numbers of days when only upper limits were

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[39] By extracting data after September 1990, we are also able to avoid the complication of Saturday trading on the TSE, since after Februry 4, 1989, Saturday trading was completely abolished on the TSE.
[40] So far, all Japanese exchange-traded ADRs are traded on either NYSE or NASDAQ, but not on AMEX.
[41] Over-the-counter traded ADRs are excluded from our sample due to their relatively low liquidity and trading volume.

reached, only lower limits were reached, and both upper and lower limits were hit consecutively.

From Table 4.2, the minimum percentage change for a stock to reach its price limits is 10%. It takes as much as 60% change for some stocks to hit their price limits. It is not surprising to see that hitting price limits is a relatively rare event. Among 25 stocks in our sample, there are 219 days that price limits were hit. The first panel in Table 4.3 lists the number of occurrences that positive price limits were reached for all 25 stocks in our sample period. In 26 trading sessions positive price limits were hit just one day. The positive price limits were hit consecutively for two days in another 23 occurrences (46 trading sessions). The number of trading sessions that positive price limits were reached is 95.

**4.4 A Model of Price Differentials**

The key assumption in our study is that one may “predict" the prices on those limit-hitting days on the TSE using the information on its ADR on the U.S. market. However, in order to make such predictions valid, the *law of one price* has to hold. In other words, an asset's price should not be affected by its location of trade, barring transaction costs. If this is not the case, profitable arbitrage opportunities would arise. Kato, Linn and Schalleim (1990) show that there are no significant differences between the prices of the ADRs and the underlying foreign stocks in their sample.

In this section, we argue that the opening price of one claim should be a continuation of the most recent closing price of the other claim if there is no new information inflow during the period when stocks are not traded. Let $p_t$ and $p_t^*$ denote the log price of an equity traded in Japan and traded as ADR respectively. Let $p_t^o$ and $p_t^c$ be opening and closing prices in logs for this equity in Japan on calendar day $t$. And let $p_t^{*o}$ and $p_t^{*c}$ be opening and closing prices in logs for its ADR in the United States on calendar day $t$. Both prices are in the same currency. Specifically, we assume price continuation requires the following conditions:

$$p_t^{*o} - p_t^c = c_1 + g(I_{1t}) + \varepsilon_{1t} \qquad (1)$$

$$p_{t+1}^o - p_t^{*c} = c_2 + g(I_{2t}) + \varepsilon_{2t} \qquad (2)$$

where $I_{t1}$ and $I_{t2}$ are the information flows during the period where both market are closed; $c_1$ and $c_2$ are used to characterize the transaction cost of arbitraging two equities, which may be assumed to be constant from day to day; and $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are random noises from this process.

Ideally, we would like to use Equation (1) to estimate the transaction costs and effects of information flow and thus “recover" the closing price on TSE on those limit-hitting days. Such estimation involves using the opening prices on the U.S. market, however. Stoll and Whaley (1990) find that on average it takes 5 minutes for large stocks and 67.4 minutes for small stocks on the New York Stock Exchange for the first transaction to take place after the market opens. Due to the delay in trading, the reported opening price does not accurately reflect the true price value of the stock; in our case, the true price value of the ADR. Therefore, we avoid this “nonsynchronous trading problem" or “stale quote problem" by using the closing prices on the U.S. market, and at the same time controlling for the U.S. market index.[42] Arguably, another reason that we can do this is that on the U.S. market from open to close it is nighttime on the TSE, so there is little new information coming from there to the U.S. market. To take into account the information flow, we also add the Nikkei 225 index to the right-hand side of Equation (1). Finally, as institutions are the major investors of ADRs, liquidity might play an important role.[43] For this reason, we add the daily share trading volumes of both the ADRs and the underlying stocks. Therefore, the equation we estimate becomes

$$p_t^{*c} - p_t^c - FX_t = c_1 + \alpha_1 I_t^* + \alpha_2 I_t + \alpha_3 V_t^* + \alpha_4 V_t + \varepsilon_t \qquad (3)$$

$$\varepsilon_{it} = u_{it}(a_0 + a_1 \varepsilon_{it-1} + a_2 u_{it-1}^2)^{\frac{1}{2}} \qquad (4)$$

where $p_t^{*c}$ and $p_t^c$ are in local currency; $FX_t$ represents the change in the foreign exchange rate between the dollar and yen. We impose a GARCH (1,1) structure on the disturbances.

[42] We use the S&P 500 as the market index. If CRSP value-weighted or equally weighted indexes are used, the results are essentially the same.
[43] The daily trading volume of some illiquid ADRs may not satisfy institutional investors’ one block of order.

In Table 4.4 we report the estimation results for Equation (3). We also calculate the mean level of the price differentials in U.S. dollars, as well as the proportion of it in the share price on TSE after considering the exchange rate and ARD ratios. We discuss the results on the price differentials between the ADRs and the underlying stocks in the concluding remarks. From Table 4.5 we can see that a GARCH model on the disturbances is an appropriate representation, as for almost all stocks the coefficients are significant at 5% level and the adjusted $R^2$ are reasonably high.

### 4.5 Effects of Price Limits on Equities

After estimating the model, we now turn to the main focus of this paper: to what extent do the price limits affect the moments of the stock returns?

Let $\tau$ denote the days that price limits are hit. After we estimate the model in Equation (3), we may calculate the predicted values $\hat{p}_{i\tau}^{c}$ for the days that price limits are hit, and then get the predicted returns using

$$\hat{r}_{i\tau} = \hat{p}_{i\tau}^{c} - p_{i\tau-1}^{c} \qquad (5)$$

It is slightly more difficult to find out the variance of the returns on the days that price limits are hit. Consider the following decomposition:

$$\hat{r}_{i\tau} = \hat{p}_{i\tau}^{c} - p_{i\tau}^{c} + p_{i\tau}^{c} - p_{i\tau-1}^{c} = \hat{p}_{i\tau}^{c} - p_{i\tau}^{c} + r_{i\tau}^{c} \qquad (6)$$

Note we are interested in $Var(r_{i\tau})$ instead of $Var(\hat{r}_{i\tau})$. It can be shown that

$$Var(r_{i\tau}) = Var(\hat{r}_{i\tau}) - Var(\hat{p}_{i\tau}^{c}) + 2Cov(r_{i\tau}^{c}, \hat{p}_{i\tau}^{c}) \qquad (7)$$

which is the variance for the predicted returns on limit-hitting days. The mean on those days would just be the sample average

$$E[r_\tau] = \frac{1}{N}\sum_\tau r_\tau \qquad (8)$$

Based on the estimated closing prices on limit-hitting days on the TSE, we can get the “predicted" returns that would have occurred if there were no price limits. We then compare the first and second moments of those predicted returns (if there were *no* price limits) with the moments of those observed returns (when there *are* price limits). When calculating the moments when there are price limits, rather than using the moments of just the limit-hitting days, we use the moments of the Wei-Chiang series. Wei and Chiang (2004) show that the moments of these series are consistent estimators of the moments of the returns on the limit-hitting days. As discussed in Section 4.1, the Wei-Chiang series is constructed by replacing the returns on limit-hitting days, and the day immediately after, with the average returns of these days. The means and variance of these days can be obtained from the following equations:

$$E[r_\tau] = \frac{1}{N}\sum_\tau r_\tau \qquad (9)$$

$$Var[r_\tau] = \frac{\sum_{j=1}^{K}\sum_{\tau\in S_j}(j+1)^2(\hat{r}_\tau - E[r_\tau])^2}{N} \qquad (10)$$

Standard errors of these comparisons are bootstrapped.

Table 4.6 reports our main results. We divide the sample into three subsamples. In the first sample, only the days that positive limits were hit consecutively are used. The second sample consists of the days that only negative limits were reached consecutively. The third sample has the days where the price limits were hit from two directions in a row. For each sample, we calculate the means and the variances from the Wei-Chiang series and from the predicted sequences. We then calculate the difference between the moments of the Wei-Chiang series and the predicted sequence. The Wei-Chiang series includes the C-H effect of price limits if it exists while the predicted sequence does not have any C-H effect. The difference between the moments of the two sequences is the C-H effect. Although not significant, when positive limits were hit, the Wei-Chiang sequence has a larger but statistically insignificant mean. When the negative limits are hit, the Wei-Chiang sequence has a smaller but statistically insignificant mean than the predicted sequence. In terms of the difference in variance, the Wei-Chiang sequence has statistically smaller variance than the predicted sequence when positive limits were hit. This results indicates that a lower variance caused by the price limits, a cooling-off effect when the positive price limits were hit. In summary, there are no significant differences in the mean and variance between the observed returns (with price limits) and the predicted returns (without price limits).

## 4.6 Conclusion

In this paper, we use a “natural experiment" comparing a stock which is traded in two marketplaces, where one is subject to price limits while the other is not, to identify the effect of price limits.

Realizing the price differentials on the two markets might not be negligible, we explicitly estimate the price differentials for all of the stocks in our sample. From the first and last columns of Table 4.4, we can see that the dollar value of the price differential per domestic share varies from about $0.01 to $1.64, and that the percentage of it ranges from 0.02% to 1.68%. For example, for TDK Corp., whose ADR is traded at a 1:1 ratio, the mean difference of $0.20 is statistically significant at the 5% level. But given that this stock was traded around $69.88 during the sample period, in an economic sense it would be difficult to believe that the $0.20 difference exceeded the bid-ask spread for this stock. We also note that the market conditions in the U.S. market seem to play a much more important role than those in the Japanese market. The price difference between TDK's ADR and its shares in Japan will increase $0.28 (or decrease $0.06) if the S&P 500 increases 1% (or the Nikkei 225 index increases by 1%), keeping all else equal. Also, the trading volume of TDK's ADR negatively affects the price difference. If the trading volume of its ADR increases by 1,000 shares, the price difference would decrease by $0.000 3. The trading volume of TDK's shares in Japan does not seem to contribute to the price difference in any direction. Overall, out of the 28 stocks in our sample, we find: 22 stocks are significantly positively related to the U.S. market; only 8 are significantly negatively related to the Japanese market, and the rest do not have significant relation with the Japanese market; 19 are negatively affected by its trading volumes in the U.S. market, although only 9 are significant; 17 are positively affected by the share's trading volume in the Japanese market; and 9 of them are significant.

We use the information on the U.S. market to estimate the price differential between the two claims and then predict what the price would have been on the TSE if there were no price limits. We then predict the moments for the days that price limits were hit and use the predicted moments to compare with the observed stock moments. We conclude that price limits do not have a significant effect on the means and variances, so the proposed intent is not supported by our analysis.

# Appendix A

## Supplemental Explanations on some Issues

## in Chapter 2

## A.1 Stocks Selected

One concern with allowing the testing periods to overlap is that we may be double-counting some stocks. We checked this possibility using different measures of the chance of a stock to be picked as an extremely high-volume or an extremely low-volume stock in two adjacent intervals. For stocks selected in a given interval, we calculated the probability of being chosen again for a following interval. Alternatively, for stocks selected in a subsequent interval, we calculated the probability of being chosen in the preceding interval. With any measure, we find that the new sampling procedure with eleven days between testing periods has almost the same probability as does the previous procedure with more days between testing periods. Both procedures have a probability of a stock being in an extreme volume portfolio of close to 20%, independent of whether the stock was chosen in an adjacent interval or not.

## A.2. Low Power of Tests

One potential explanation for the lack of results in Belgium, Norway and the emerging markets is that the power of the tests is simply too low due to lack of data, both in terms of an inadequate time series and in terms of the number of securities traded in those countries. For example, Belgium has 74 intervals and an average of 41 stocks per interval. Norway has a longer time series of intervals, but averages only 59 stocks per interval. To test whether low power could explain the lack of significant results for these countries, we conduct an alternative series of tests that allow for overlapping testing periods. The overlapping test period approach provides more intervals and consequently, greater power in the tests. We start the subsequent test periods eleven days after the former period, rather than twenty-one days as in the previous approach. The results for the reference return portfolios and zero-investment portfolios, shown in Table A1, are consistent with the hypothesis that lack of power explains the lack of significant results for some countries. With the increased number of testing periods, we find that all but one developed country (Belgium) and 14 of the 21 emerging countries now have significant high volume return premiums on the 20$^{th}$ day (according to the reference return portfolios).

We still have not completely eliminated the low power problem however. Although we can adapt the testing methodology to include more intervals by overlapping the periods, we cannot increase the average number of stocks in the intervals. Thus, for countries such as Belgium, which have a limited number of stocks, we still have low power. As a further test of whether the low power can explain the lack of a significant high volume return premium, we tried adding stocks traded on Belgium's second exchange to the analysis. With the addition of more stocks, we find a significant high volume return premium, further supporting our conjecture that low power is partly responsible for the lack of statistically significant premiums in some of the countries.[44]

[44] Unfortunately, adding stocks from a second exchange is not a feasible solution to the power problem for two reasons. First, Belgium is one of only a small number of countries with a large second exchange. Second, as noted in an earlier footnote, there may be differences in visibility across exchanges, which could confound our tests.

### A.3. Systematic Risk Differences

A possible explanation for the premium we find associated with the high volume is that the high volume stocks have higher systematic risk than do the low volume stocks. To test for this possibility, for each country we compute the average beta across the high volume and low volume stocks separately and then compare the differences. The results are shown in Table A2. As the table shows, in general, there are no significant differences between the two groups in terms of their betas. In the cases in which a significant difference does occur, they are in the wrong direction.

# Appendix B

# Tables

## Table 2.1
## Descriptive Statistics on Country Intervals for High Volume Return Premium Measurement

This table presents descriptive statistics for the 41 countries with sufficient data. The table shows the country, its region, the start date of the volume data, the number of testing period intervals over the available sample period, and the average number of stocks in each interval.

| Country | Start Date | Number of Intervals | Average Number of Stocks |
|---|---|---|---|
| ARGENTINA | Jul-93 | 91 | 28 |
| AUSTRALIA | Jan-84 | 208 | 193 |
| AUSTRIA | Jul-90 | 120 | 50 |
| BANGLADESH | Jan-92 | 99 | 67 |
| BELGIUM | Jan-94 | 74 | 41 |
| BRAZIL | Jan-99 | 27 | 136 |
| CANADA | Jan-73 | 330 | 345 |
| CHILE | Jul-89 | 129 | 67 |
| CHINA | Aug-91 | 110 | 186 |
| DENMARK | Jul-90 | 119 | 71 |
| EGYPT | Jan-97 | 55 | 34 |
| FRANCE | Jun-88 | 149 | 205 |
| GERMANY | Jun-88 | 150 | 138 |
| GREECE | Jan-88 | 147 | 100 |
| HONG KONG | Jun-88 | 151 | 189 |
| INDIA | Jan-95 | 72 | 250 |
| INDONESIA | Jan-95 | 71 | 71 |
| ITALY | Jul-86 | 175 | 93 |
| JAPAN | Jan-90 | 134 | 1181 |
| KOREA | Sep-87 | 158 | 345 |
| MALAYSIA | Jan-86 | 179 | 235 |
| MEXICO | Jan-88 | 148 | 36 |
| MOROCCO | Jul-93 | 87 | 24 |
| NETHERLANDS | Feb-86 | 182 | 107 |
| NEW ZEALAND | Jan-90 | 134 | 56 |
| NORWAY | Jan-86 | 172 | 59 |
| PAKISTAN | Jul-92 | 107 | 43 |
| PHILLIPPINES | Jan-90 | 133 | 49 |
| POLAND | Jan-94 | 82 | 57 |
| PORTUGAL | Jan-90 | 132 | 34 |
| SINGAPORE | Jan-83 | 217 | 88 |
| SOUTH AFRICA | Jan-96 | 63 | 221 |
| SPAIN | Jan-91 | 123 | 85 |
| SRI LANKA | Jan-88 | 163 | 36 |
| SWEDEN | Jul-87 | 159 | 131 |
| SWITZERLAND | Jan-89 | 140 | 65 |
| TAIWAN | Apr-91 | 114 | 119 |
| THAILAND | Jan-87 | 157 | 102 |
| TURKEY | Jan-88 | 147 | 62 |
| UK | Oct-86 | 174 | 517 |
| US | Aug-63 | 445 | 1407 |
| **Average** | | **142** | **179** |

## Table 2.2
## 20th Day Return Spreads by Country

This table shows the 20th day return spread between the high-volume and low-volume portfolio for each country along with a Newey-West t-statistic of a test of whether the spread is significantly different from zero. Panel A contains the developed markets and Panel B, the emerging markets.

### Panel A. Developed Markets

| Country | 20th-Day Spread | t-statistic |
|---|---|---|
| **G7 Countries** | | |
| US | 1.43 | 35.97*** |
| JAPAN | 2.31 | 24.71*** |
| UK | 1.79 | 13.08*** |
| CANADA | 2.22 | 12.48*** |
| FRANCE | 1.80 | 8.63*** |
| GERMANY | 1.88 | 7.25*** |
| ITALY | 2.87 | 9.65*** |
| **Other Developed Countries** | | |
| AUSTRALIA | 1.49 | 5.99*** |
| HONG KONG | 3.42 | 9.89*** |
| SWEDEN | 1.40 | 4.55*** |
| NETHERLANDS | 0.67 | 2.83*** |
| SINGAPORE | 2.09 | 6.93*** |
| SPAIN | 1.81 | 5.50*** |
| DENMARK | 1.65 | 4.29*** |
| SWITZERLAND | 1.07 | 3.28*** |
| NORWAY | -0.03 | -0.50 |
| NEW ZEALAND | 1.43 | 3.04*** |
| AUSTRIA | 1.40 | 2.77*** |
| BELGIUM | 0.65 | 0.95 |
| PORTUGAL | 2.06 | 3.55*** |
| **Developed Countries Pooled** | 1.75 | 22.15*** |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

## Table 2.2 – continued

**Panel B. Emerging Markets**

| Country | 20th-Day Spread | t-statistic |
|---|---|---|
| KOREA | 1.67 | 6.25*** |
| INDIA | 0.39 | 0.76 |
| MALAYSIA | 3.16 | 11.83*** |
| SOUTH AFRICA | 0.99 | 1.58 |
| CHINA | 2.55 | 5.58*** |
| BRAZIL | 4.49 | 4.93*** |
| TAIWAN | 1.72 | 3.67*** |
| THAILAND | 2.70 | 5.89*** |
| GREECE | 3.16 | 5.86*** |
| INDONESIA | 4.78 | 3.48*** |
| CHILE | 1.51 | 3.97*** |
| BANGLADESH | 2.51 | 0.63 |
| TURKEY | 4.90 | 5.30*** |
| POLAND | 1.84 | 1.89* |
| PHILLIPPINES | 3.32 | 4.89*** |
| PAKISTAN | -0.06 | -0.14 |
| SRI LANKA | 1.57 | 0.91 |
| MEXICO | 3.42 | 5.40*** |
| EGYPT | 0.88 | 0.12 |
| ARGENTINA | 1.33 | 2.16** |
| MOROCCO | 1.31 | 1.49 |
| **Emerging Markets Pooled** | 2.90 | 4.29*** |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

## Table 2.3
## 20th Day Returns by Country on Zero-investment and Reference Return Portfolios

This table shows the average return for zero-investment and reference return portfolios held for 20 days after the portfolio formation. The portfolios are constructed on a country by country basis and consist of long positions in extreme high volume stocks and short positions in extreme low volume stocks, where extreme high and low volume are defined as of the portfolio formation dates. Panel A contains the developed markets and Panel B, the emerging markets. Also included are Newey-West t-statistics.

**Panel A. Developed Markets**

| Country | Average return for zero-investment portfolios held for 20 days | t-statistic | Average return for reference return portfolios held for 20 days | t-statistic |
|---|---|---|---|---|
| **G7 Countries** | | | | |
| US | 1.04 | 15.37*** | 0.44 | 25.27*** |
| JAPAN | 1.30 | 3.64*** | 0.56 | 14.73*** |
| UK | 1.16 | 6.66*** | 0.66 | 10.27*** |
| CANADA | 1.18 | 4.73*** | 0.82 | 9.43*** |
| FRANCE | 1.38 | 4.04*** | 0.55 | 5.82*** |
| GERMANY | 1.00 | 4.01*** | 0.47 | 4.07*** |
| ITALY | 0.67 | 1.64 | 0.25 | 1.93* |
| **Other Developed Countries** | | | | |
| AUSTRALIA | 0.75 | 2.53*** | 0.32 | 2.80*** |
| HONG KONG | 0.97 | 2.21*** | 0.52 | 3.53*** |
| SWEDEN | 0.68 | 1.69* | 0.49 | 3.61*** |
| NETHERLANDS | 0.30 | 0.95 | 0.12 | 1.15 |
| SINGAPORE | 1.59 | 4.02*** | 0.50 | 4.45*** |
| SPAIN | 1.23 | 3.73*** | 0.27 | 4.68*** |
| DENMARK | 1.02 | 1.63 | 0.26 | 4.10*** |
| SWITZERLAND | 0.65 | 2.11*** | 0.43 | 3.08*** |
| NORWAY | 0.12 | 0.25 | -0.02 | -0.19 |
| NEW ZEALAND | 1.57 | 3.67*** | 0.31 | 4.04*** |
| AUSTRIA | 0.65 | 1.48 | 0.16 | 2.34** |
| BELGIUM | 1.44 | 2.77*** | 0.44 | 1.66* |
| PORTUGAL | 1.52 | 2.01** | 0.25 | 2.37** |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

## Table 2.3 – continued

**Panel B. Emerging Markets**

| **Country** | **Average return for zero-investment portfolios held for 20 days** | **t-statistic** | **Average return for reference return portfolios held for 20 days** | **t-statistic** |
|---|---|---|---|---|
| KOREA | 0.42 | 0.79 | 0.12 | 1.03 |
| INDIA | 1.64 | 1.69* | 0.43 | 1.93* |
| MALAYSIA | 1.10 | 2.02** | 0.23 | 2.42** |
| SOUTH AFRICA | 1.11 | 2.32** | 0.17 | 1.80* |
| CHINA | 0.43 | 0.43 | -1.49 | -0.08 |
| BRAZIL | 1.62 | 1.89* | 0.38 | 2.28** |
| TAIWAN | 0.36 | 0.59 | 0.00 | -0.05 |
| THAILAND | 2.08 | 3.20*** | 0.91 | 5.01*** |
| GREECE | 1.24 | 2.20** | 0.21 | 1.88* |
| INDONESIA | 2.70 | 2.54** | 0.31 | 1.61 |
| CHILE | 0.69 | 1.72* | 0.12 | 1.61 |
| BANGLADESH | 1.68 | 1.25 | 0.16 | 1.43 |
| TURKEY | 1.44 | 0.99 | 0.14 | 0.87 |
| POLAND | -0.49 | -0.51 | 0.16 | 1.35 |
| PHILLIPPINES | 0.28 | 0.09 | 0.07 | 0.06 |
| PAKISTAN | 0.97 | 1.36 | 0.13 | 1.12 |
| SRI LANKA | 3.91 | 1.01 | 7.26 | 1.25 |
| MEXICO | 0.68 | 0.73 | 0.27 | 2.80** |
| EGYPT | -0.57 | -0.56 | 0.03 | 0.19 |
| ARGENTINA | 0.11 | 0.12 | 0.07 | 0.54 |
| MOROCCO | 0.97 | 1.41 | 0.12 | 0.76 |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

**Table 2.4**

**Descriptive Statistics on Country and Market Characteristics**

This table provides descriptive statistics on the country and market characteristic variables, including the mean, median, maximum, minimum and the standards deviation of each variable.

| Category | Variable | Mean | Median | Maximum | Minimum | Standard Deviation |
|---|---|---|---|---|---|---|
| Country Demographics | Listed companies per million urban people | 27.13 | 22.33 | 86.18 | 0.91 | 21.41 |
| | School enrollment, secondary (% gross) | 90.62 | 95.93 | 172.34 | 19.89 | 32.31 |
| Equity Market Characteristics | Ratio of mean market value of 10th decile/ 2nd decile | 9801 | 190 | 390353[a] | 9 | 60919 |
| | Share of largest three industries | 0.53 | 0.51 | 0.93 | 0.24 | 0.15 |
| | Average $R^2$ of market model | 0.12 | 0.12 | 0.49 | 0.03 | 0.10 |
| Investor Confidence | Accounting standards index[b] | 62.91 | 64 | 83 | 24 | 12.06 |
| | Country credit rating | 60.21 | 64.40 | 93.70 | 20.70 | 23.39 |
| | ICRG | 75.81 | 80.50 | 94.00 | 40.00 | 15.04 |

[a] The second largest value is 1978.
[b] The accounting standards index is available for only 34 countries in the sample.

## Table 2.5

### Pairwise Comparisons of 20th Day Reference Return Portfolios Divided by Market Characteristics

This table shows the difference between the 20th day return (in percent) for country reference return portfolios divided into two or three groups according to each of the characteristics. The table shows the returns on portfolios in the top-third or bottom-third of each characteristic. The table also shows a Newey-West t-statistic for the difference.

| Category | Variable | Difference | t-statistic |
|---|---|---|---|
| Country Demographics | Listed companies per urban population | 0.48 | 2.09** |
| | Secondary school enrollment | -0.28 | -1.92* |
| Market Characteristics | Market value ratio | 1.12 | 1.89* |
| | Share of largest 3 industries | 0.55 | 1.97** |
| | Average $R^2$ of market model | 0.42 | 1.97* |
| Investor Confidence | Accounting standards index | -0.31 | -1.07 |
| | Country credit rating | -0.74 | -2.02** |
| | ICRG | -0.49 | -1.79* |
| | Short selling allowed | -0.68 | -1.70* |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

## Table 2.6

### Correlation of Explanatory Variables

This table shows the Pearson correlations between the pairs of explanatory variables with significance levels provided below the correlations.  Correlations that are significant beyond the 5% level are highlighted.

| | Market Value Ratio | Largest 3 industries' share | Avg $R^2$ | Acctg Stnd Index | Country Credit Rating | ICRG | Listed Co. per Urban Population |
|---|---|---|---|---|---|---|---|
| **Share of largest 3 industries** | **0.378**<br>**0.015** | | | | | | |
| **Average $R^2$ of market model** | -0.114<br>0.508 | -0.251<br>0.140 | | | | | |
| **Accounting standards index** | -0.130<br>0.462 | -0.289<br>0.097 | 0.141<br>0.435 | | | | |
| **Country credit rating** | -0.209<br>0.189 | -0.229<br>0.149 | -0.116<br>0.608 | **0.495**<br>**0.023** | | | |
| **ICRG** | -0.213<br>0.296 | -0.069<br>0.744 | -0.200<br>0.243 | **0.403**<br>**0.020** | **0.821**<br>**0.001** | | |
| **Listed comp. per urban population** | -0.175<br>0.281 | -0.310<br>0.052 | -0.167<br>0.337 | **0.445**<br>**0.009** | **0.382**<br>**0.015** | 0.325<br>0.106 | |
| **Secondary school enrollment** | -0.149<br>0.353 | -0.128<br>0.424 | -0.340<br>0.043 | 0.263<br>0.133 | **0.624**<br>**0.001** | **0.714**<br>**0.001** | 0.281<br>0.079 |
| **Legality of Short Selling** | 0.134<br>0.513 | -0.264<br>0.159 | **-0.459**<br>**0.031** | 0.306<br>0.178 | **0.471**<br>**0.020** | **0.604**<br>**0.001** | 0.059<br>0.774 |

## Table 2.7

## Fama MacBeth Regressions of Extreme Volume Returns on Market Characteristics

This table shows the results of Fama-MacBeth regression tests on the market characteristic variables each period. The dependent variable is the 20th day return on the country reference return portfolios. The table shows the mean coefficients from the series of regressions (along with a Fama-MacBeth t-test (Newey-West t-statistic) of the significance of the mean coefficients) in which Models 1-4 include the four investor confidence variables separately. Also included are the average $R^2$'s from the regressions.

| | | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | **Variable** | **Mean coefficient** | **t-statistic** | **Mean coefficient** | **t-statistic** | **Mean coefficient** | **t-statistic** | **Mean coefficient** | **t-statistic** |
| | Intercept | 1.25 | 0.57 | 1.38 | 0.98 | 1.19 | 1.24 | -0.42 | -0.41 |
| Demographics | Listed co. per urban pop. | 0.11 | 1.97** | 0.12 | 1.94* | 0.12 | 1.98** | 0.09 | 1.96** |
| | Sec. school enrollment | -0.003 | -0.47 | 0.044 | 1.51 | -0.02 | -0.68 | -0.01 | -0.30 |
| Market Characteristics | Market value ratio | 0.003 | 1.82* | 0.003 | 1.79* | 0.003 | 1.97** | 0.002 | 1.81* |
| | Share of lgst 3 industries | 0.48 | 2.11** | 0.47 | 2.00** | 0.49 | 1.81* | 0.508 | 1.94* |
| | Average $R^2$ – mkt model | 1.36 | 1.96** | 1.35 | 1.62 | 1.42 | 2.01** | 1.10 | 0.88 |
| Investor Confidence | Accounting standards | -0.01 | -2.01** | | | | | | |
| | Country credit rating | | | -0.04 | -1.69* | | | | |
| | ICRG | | | | | -0.02 | -1.95* | | |
| | Short selling allowed | | | | | | | -0.22 | -1.23 |
| Control Variables | Emerging Market | -0.06 | -0.15 | -0.07 | -1.21 | -0.38 | -0.40 | 1.01 | 2.08** |
| | G-7 | 0.77 | 1.93* | 0.71 | 1.89* | 0.84 | 1.94* | 0.98 | 1.75* |
| | Turnover ratio | 0.001 | 0.59 | 0.0007 | 1.19 | 0.004 | 1.28 | -0.004 | -0.79 |
| | Medium Size Firms | -0.22 | -3.41*** | -0.19 | -2.58*** | -0.21 | -2.92** | -0.20 | -2.92*** |
| | Large Size Firms | -0.33 | -6.90*** | -0.30 | -5.42*** | -0.31 | -4.11*** | -0.30 | -5.45*** |
| | Scandinavian Law | -0.03 | -0.08 | -0.29 | -0.94 | 0.23 | 0.71 | -0.144 | -0.345 |
| | French Law | -0.16 | -0.45 | -0.55 | -1.08 | 0.48 | 0.96 | 0.259 | 0.329 |
| | German Law | -0.15 | -0.35 | -0.27 | -0.71 | 0.72 | 1.08 | 0.67 | 0.89 |
| | Equally-weighted volatility | -32.73 | -0.12 | 1.59 | 0.0009 | -31.27 | -0.79 | -22.17 | -0.81 |
| | High volume dummy | -0.16 | -0.64 | -0.24 | -0.94 | -0.21 | -0.77 | -0.48 | -1.02 |
| Number of Cross-Sectional Regressions: 155 in all models | | | | | | | | | |
| Time-series Avg. Adj. $R^2$: Model 1: 0.038 Model 2: 0.037 Model 3: 0.037 Model 4: 0.035 | | | | | | | | | |

## Table 2.8

### 20th Day Zero-investment and Reference Return Portfolio Returns

### by Country with Overlapping Test Periods

This table shows the average return for zero-investment and reference return portfolios held for 20 days after the portfolio formation. The portfolios are constructed on a country by country basis and consist of long positions in extreme high volume stocks and short positions in extreme low volume stocks, where extreme high and low volume are defined as of the portfolio formation dates. Panel A contains the developed markets and Panel B, the emerging markets. Also included are Newey-West t-statistics.

**Panel A. Developed Markets**

| Country | Number of Intervals | Number of Stocks | Average return for zero-investment portfolios held for 20 days | t-statistic | Average return for reference return portfolios held for 20 days | t-statistic |
|---|---|---|---|---|---|---|
| **G7 Countries** | | | | | | |
| US | 851 | 1293 | 0.85 | 18.90*** | 0.39 | 29.80*** |
| JAPAN | 258 | 1165 | 0.86 | 3.01*** | 0.49 | 18.10*** |
| UK | 333 | 515 | 1.01 | 7.76*** | 0.69 | 14.30*** |
| CANADA | 630 | 357 | 1.28 | 6.44*** | 0.86 | 14.10*** |
| FRANCE | 293 | 199 | 0.98 | 3.09*** | 0.61 | 7.90*** |
| GERMANY | 294 | 132 | 1.10 | 5.33*** | 0.51 | 6.19*** |
| ITALY | 339 | 92 | 1.36 | 4.47*** | 0.50 | 6.03*** |
| **Other Developed countries** | | | | | | |
| AUSTRALIA | 397 | 194 | 1.09 | 4.93*** | 0.57 | 6.02*** |
| HONG KONG | 289 | 186 | 1.40 | 4.43*** | 0.61 | 5.68*** |
| SWEDEN | 304 | 131 | 0.99 | 3.71*** | 0.51 | 5.34*** |
| NETHERLANDS | 349 | 108 | 0.97 | 4.99*** | 0.44 | 5.16*** |
| SINGAPORE | 415 | 88 | 0.98 | 3.42*** | 0.41 | 4.96*** |
| SPAIN | 236 | 82 | 1.05 | 4.13*** | 0.43 | 4.40*** |
| DENMARK | 232 | 69 | 1.85 | 3.70*** | 0.44 | 3.56*** |
| SWITZERLAND | 279 | 63 | 0.8 | 3.43*** | 0.34 | 3.33*** |
| NORWAY | 349 | 57 | 0.45 | 1.23 | 0.28 | 2.16** |
| NEW ZEALAND | 257 | 56 | 0.55 | 1.32 | 0.56 | 4.29*** |
| AUSTRIA | 230 | 49 | 1.47 | 4.68*** | 0.61 | 5.18*** |
| BELGIUM | 146 | 40 | 0.76 | 1.71 | 0.31 | 1.52 |
| PORTUGAL | 253 | 35 | 1.29 | 2.51** | 0.67 | 3.78*** |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

## Table 2.8 – Continued

**Panel B. Emerging Markets**

| Country | Number of Intervals | Number of Stocks | Average return for zero-investment portfolios held for 20 days | t-statistic | Average return for reference return portfolios held for 20 days | t-statistic |
|---|---|---|---|---|---|---|
| KOREA | 301 | 345 | 0.36 | 0.99 | 0.21 | 2.54** |
| INDIA | 139 | 244 | 1.40 | 2.37** | 0.42 | 2.51** |
| MALAYSIA | 342 | 236 | 0.22 | 0.58 | 0.15 | 2.16** |
| SOUTH AFRICA | 120 | 223 | 1.17 | 3.62*** | 0.50 | 3.19*** |
| CHINA | 215 | 182 | 0.67 | 0.78 | 0.24 | 2.99*** |
| BRAZIL | 51 | 138 | 0.66 | 1.00 | 0.35 | 1.30 |
| TAIWAN | 219 | 120 | -0.07 | -0.13 | -0.02 | -0.22 |
| THAILAND | 301 | 102 | 2.21 | 5.10*** | 0.85 | 6.16*** |
| GREECE | 281 | 100 | 1.41 | 3.45*** | 0.56 | 3.00*** |
| INDONESIA | 141 | 69 | 2.94 | 3.70*** | 1.25 | 3.93*** |
| CHILE | 247 | 68 | 0.46 | 1.39 | 0.35 | 2.82*** |
| BANGLADESH | 195 | 66 | 1.88 | 2.68*** | 0.67 | 2.74*** |
| TURKEY | 281 | 61 | 3.77 | 3.13*** | 0.81 | 2.45** |
| PHILLIPPINES | 255 | 50 | 3.80 | 2.13** | 2.58 | 1.82* |
| PAKISTAN | 204 | 43 | 0.26 | 0.49 | 0.02 | 0.09 |
| MEXICO | 283 | 36 | 2.16 | 4.36*** | 0.70 | 4.34*** |
| SRI LANKA | 311 | 36 | 0.02 | 0.03 | 0.09 | 0.45 |
| EGYPT | 105 | 34 | 0.79 | 0.87 | 0.04 | 0.13 |
| POLAND | 157 | 30 | 3.30 | 2.59*** | 0.96 | 3.40*** |
| ARGENTINA | 175 | 28 | 0.81 | 1.21 | 0.28 | 1.09 |
| MOROCCO | 166 | 24 | 0.42 | 0.79 | -0.05 | -0.22 |

*** significant at the 1% level
** significant at the 5% level
* significant at the 10% level

## Table 2.9

## Differences in Systematic Risk between High Volume and

## Low Volume Stocks by Country

This table shows by country, the average systematic risk estimates (betas) for stocks with high volume shocks and stocks with low volume shocks. Panel A contains the developed markets and Panel B, the emerging markets.

**Panel A. Developed Countries**

| | High Volume Stocks | | Low Volume Stocks | | | | |
|---|---|---|---|---|---|---|---|
| **Country** | **Estimate** | **p-value** | **Estimate** | **p-value** | **High beta less low beta** | **pValue** | **Adj. Rsq.** |
| **G7 Countries** | | | | | | | |
| ITALY | 0.776 | 0.0000 | 0.827 | 0.0000 | -0.051 | 0.4134 | 0.61 |
| GERMANY | 0.752 | 0.0000 | 0.768 | 0.0000 | -0.016 | 0.7453 | 0.49 |
| FRANCE | 0.732 | 0.0000 | 0.697 | 0.0000 | 0.035 | 0.5914 | 0.51 |
| CANADA | 0.917 | 0.0000 | 0.846 | 0.0000 | 0.070 | 0.2013 | 0.49 |
| UK | 0.865 | 0.0000 | 0.903 | 0.0000 | -0.038 | 0.3097 | 0.59 |
| JAPAN | 1.157 | 0.0000 | 1.123 | 0.0000 | 0.034 | 0.4720 | 0.68 |
| US | 0.952 | 0.0000 | 0.971 | 0.0000 | -0.019 | 0.2933 | 0.68 |
| **Other Developed Countries** | | | | | | | |
| PORTUGAL | 0.784 | 0.0000 | 0.645 | 0.0000 | 0.138 | 0.2942 | 0.32 |
| BELGIUM | 0.632 | 0.0000 | 0.782 | 0.0000 | -0.151 | 0.1506 | 0.49 |
| AUSTRIA | 0.599 | 0.0000 | 0.896 | 0.0000 | -0.297 | **0.0015** | 0.45 |
| NEWZEAL | 0.682 | 0.0000 | 0.771 | 0.0000 | -0.089 | 0.2762 | 0.41 |
| NORWAY | 0.945 | 0.0000 | 0.963 | 0.0000 | -0.018 | 0.8013 | 0.61 |
| SWITZERL | 0.756 | 0.0000 | 0.854 | 0.0000 | -0.098 | 0.1266 | 0.44 |
| DENMARK | 0.387 | 0.0000 | 0.451 | 0.0000 | -0.063 | 0.5121 | 0.21 |
| SPAIN | 0.762 | 0.0000 | 0.693 | 0.0000 | 0.068 | 0.2538 | 0.62 |
| SINGAPOR | 1.105 | 0.0000 | 1.156 | 0.0000 | -0.051 | 0.3807 | 0.63 |
| NETHERLA | 0.894 | 0.0000 | 0.822 | 0.0000 | 0.072 | 0.2602 | 0.61 |
| SWEDEN | 0.917 | 0.0000 | 0.804 | 0.0000 | 0.113 | **0.0482** | 0.69 |
| HONGKONG | 1.042 | 0.0000 | 0.943 | 0.0000 | 0.099 | **0.0703** | 0.63 |
| AUSTRALIA | 0.849 | 0.0000 | 0.915 | 0.0000 | -0.066 | 0.2269 | 0.53 |

**Table 2.9 – continued**

**Panel B. Emerging Markets**

| | <u>**High Volume Stocks**</u> | | <u>**Low Volume Stocks**</u> | | | | |
|---|---|---|---|---|---|---|---|
| **Country** | **Estimate** | **p-value** | **Estimate** | **p-value** | **High beta less low beta** | **pValue** | **Adj. Rsq.** |
| MOROCCO | | | | | | | |
| ARGENTIN | 0.972 | 0.0000 | 0.961 | 0.0000 | 0.011 | 0.9174 | 0.61 |
| EGYPT | | | | | | | |
| MEXICO | 0.782 | 0.0000 | 0.918 | 0.0000 | -0.136 | 0.2613 | 0.47 |
| SRILANKA | | | | | | | |
| PAKISTAN | | | | | | | |
| PHILIPPI | 1.076 | 0.0000 | 0.538 | 0.0791 | 0.538 | 0.1198 | 0.24 |
| POLAND | 0.545 | 0.0000 | 0.520 | 0.0000 | 0.025 | 0.7791 | 0.40 |
| TURKEY | 0.905 | 0.0000 | 0.970 | 0.0000 | -0.065 | 0.4122 | 0.53 |
| BANGLADE | | | | | | | |
| CHILE | 0.953 | 0.0000 | 0.975 | 0.0000 | -0.022 | 0.6810 | 0.80 |
| INDONESI | 0.989 | 0.0000 | 0.795 | 0.0000 | 0.195 | **0.0350** | 0.53 |
| SHANGHAI | 0.901 | 0.0000 | 0.794 | 0.0000 | 0.106 | **0.0570** | 0.64 |
| GREECE | 0.926 | 0.0000 | 0.812 | 0.0000 | 0.114 | **0.0236** | 0.52 |
| THAILAND | 0.920 | 0.0000 | 0.790 | 0.0000 | 0.130 | **0.0164** | 0.63 |
| SHENZEN | 0.787 | 0.0000 | 1.024 | 0.0000 | -0.238 | **0.0891** | 0.48 |
| TAIWAN | 0.780 | 0.0000 | 0.741 | 0.0000 | 0.040 | 0.5375 | 0.46 |
| BRAZIL | 0.886 | 0.0000 | 0.885 | 0.0000 | 0.000 | 0.9962 | 0.82 |
| SOUTHAFR | 0.720 | 0.0000 | 0.812 | 0.0000 | -0.092 | 0.1417 | 0.68 |
| MALAYSIA | 1.137 | 0.0000 | 1.010 | 0.0000 | 0.127 | **0.0238** | 0.62 |
| INDIA | 0.989 | 0.0000 | 0.818 | 0.0000 | 0.171 | 0.1363 | 0.44 |
| KOREA | 0.642 | 0.0000 | 0.516 | 0.0000 | 0.126 | **0.0127** | 0.32 |

## Table 3.1

## Summary Statistics of the Sample Length and Number of Stocks of Each Country

Start date is the month when there are at least 10 qualified stocks in each country. Ending date is June 2001 for all countries. Average, minimum and maximum No. of stocks are statistics that describe the time series of each country.

| **Country** | **Start Date** | **Average No. Stocks** | **Min. No. Stocks** | **Max. No. Stocks** |
|---|---|---|---|---|
| AUSTRALIA | Jan-84 | 245 | 65 | 698 |
| AUSTRIA | Jan-91 | 57 | 40 | 75 |
| BELGIUM | Sep-90 | 47 | 19 | 82 |
| CANADA | Oct-73 | 399 | 35 | 1112 |
| DENMARK | Jan-91 | 52 | 13 | 135 |
| FRANCE | Jun-88 | 269 | 26 | 523 |
| GERMANY | Jun-88 | 238 | 119 | 530 |
| HONG KONG | Jun-88 | 278 | 129 | 507 |
| ITALY | Jul-86 | 127 | 27 | 305 |
| JAPAN | Jan-90 | 1297 | 32 | 1754 |
| NETHERLANDS | Feb-86 | 129 | 34 | 188 |
| NEW ZEALAND | Jan-90 | 48 | 15 | 87 |
| NORWAY | Jan-86 | 75 | 30 | 136 |
| SINGAPORE | Jan-83 | 121 | 29 | 261 |
| SPAIN | Jan-91 | 108 | 48 | 139 |
| SWEDEN | Jan-88 | 176 | 29 | 359 |
| SWITZERLAND | Jan-89 | 96 | 19 | 167 |
| UK | Oct-86 | 590 | 66 | 1087 |
| US | Aug-62 | 1722 | 950 | 2182 |
| **Average** | | **320** | **91** | **544** |

## Table 3.2

## Summary Statistics of the Market Liquidity of Each Country

For each country, each month's market liquidity is constructed by averaging individual stocks' liquidity measures for the month and then multiplying by $(m_t / m_1)$, where $m_t$ is the total traded value in local currency at the end of month $t-1$ of the stocks included in the average in month $t$, and month $1$ corresponds to the starting month of each country. An individual stock's measure for a given month is a regression slope coefficient estimated using daily returns and volume data within that month. The mean and autocorrelation of the market liquidity are using the time series of this liquidity measure for each country. Autocorrelation refers to the first-order serial correlation. Average No. of stocks is the average number of qualified stocks that are included in calculating the market liquidity.

| **Country** | **Market Liquidity** | | **Autocorrelation** | | **Average No.** |
|---|---|---|---|---|---|
| | **Mean** | **t-statistic** | **Coefficient** | **t-statistic** | **Stocks** |
| AUSTRALIA | -0.068 | -2.99*** | 0.14 | 1.63 | 245 |
| AUSTRIA | -0.001 | -1.17 | 0.24 | 2.75*** | 57 |
| BELGIUM | 0.001 | 1.56 | -0.01 | -0.41 | 47 |
| CANADA | -0.066 | -3.46*** | 0.24 | 2.19** | 399 |
| DENMARK | 0.002 | 2.78*** | 0.00 | 0.51 | 52 |
| FRANCE | -0.005 | -2.00** | 0.20 | 2.49** | 269 |
| GERMANY | -0.004 | -1.98** | 0.33 | 3.85*** | 238 |
| HONG KONG | -0.003 | -3.11*** | 0.06 | 1.04 | 278 |
| ITALY | -0.00001 | -3.85*** | -0.02 | -1.04 | 127 |
| JAPAN | -0.00003 | -4.30*** | 0.31 | 3.80*** | 1297 |
| NETHERLANDS | -0.005 | -2.56** | 0.00 | -0.04 | 129 |
| NEW ZEALAND | 0.018 | 1.22 | 0.04 | 0.44 | 48 |
| NORWAY | 0.002 | 1.15 | -0.07 | -1.31 | 75 |
| SINGAPORE | -0.035 | -3.92*** | 0.27 | 4.19*** | 121 |
| SPAIN | -0.0001 | -2.71*** | 0.00 | 0.55 | 108 |
| SWEDEN | -0.003 | -1.54 | 0.15 | 1.64* | 176 |
| SWITZERLAND | 0.001 | 0.47 | 0.31 | 3.90*** | 96 |
| UK | -0.002 | -2.24** | 0.23 | 3.08*** | 590 |
| US | -0.028 | -10.91*** | 0.22 | 4.48*** | 1722 |

## Table 3.3

### Correlation Matrix of Market Liquidity and Fama-French 3 Factors and Momentum Factor

This table reports the correlation matrix of the market liquidity, Fama-French 3 factors and a momentum factor. The correlation coefficient significant at least at the 10% level is bolded.

| Country | Factor | Market | SMB | HML | WML |
|---|---|---|---|---|---|
| AUSTRALIA | SMB | **0.19** | | | |
| | HML | **-0.21** | 0.07 | | |
| | WML | 0.08 | **-0.20** | **-0.16** | |
| | Liquidity (Lt) | **0.16** | **0.15** | 0.03 | -0.07 |
| AUSTRIA | SMB | **0.66** | | | |
| | HML | **0.24** | **-0.21** | | |
| | WML | **-0.22** | 0.00 | **-0.18** | |
| | Liquidity (Lt) | -0.01 | 0.00 | 0.01 | 0.14 |
| BELGIUM | SMB | **0.61** | | | |
| | HML | **-0.31** | **0.44** | | |
| | WML | **0.20** | **-0.17** | **-0.20** | |
| | Liquidity (Lt) | 0.10 | 0.05 | -0.03 | -0.03 |
| CANADA | SMB | **0.27** | | | |
| | HML | **-0.29** | **-0.18** | | |
| | WML | **0.28** | 0.11 | **-0.40** | |
| | Liquidity (Lt) | **0.18** | **0.19** | **-0.15** | 0.10 |
| DENMARK | SMB | **0.56** | | | |
| | HML | **-0.14** | -0.04 | | |
| | WML | 0.11 | 0.11 | -0.11 | |
| | Liquidity (Lt) | -0.05 | -0.07 | 0.04 | **-0.16** |
| FRANCE | SMB | **0.50** | | | |
| | HML | 0.02 | -0.07 | | |
| | WML | 0.00 | **0.21** | **-0.25** | |
| | Liquidity (Lt) | **0.15** | 0.13 | **-0.19** | **0.29** |
| GERMANY | SMB | **0.51** | | | |
| | HML | **-0.21** | -0.14 | | |
| | WML | **0.21** | **-0.32** | -0.10 | |
| | Liquidity (Lt) | **0.18** | **0.15** | 0.05 | **0.23** |
| HONG KONG | SMB | **0.45** | | | |
| | HML | **0.47** | **-0.26** | | |
| | WML | **-0.15** | 0.12 | **-0.38** | |
| | Liquidity (Lt) | 0.07 | -0.01 | -0.07 | 0.12 |

**Table 3.3 – Continued**

| Country | Factor | Market | SMB | HML | WML |
|---|---|---|---|---|---|
| ITALY | SMB | 0.08 | | | |
| | HML | 0.07 | **-0.19** | | |
| | WML | 0.08 | -0.07 | **-0.41** | |
| | Liquidity (Lt) | -0.08 | 0.10 | -0.04 | -0.08 |
| JAPAN | SMB | 0.13 | | | |
| | HML | -0.05 | **0.42** | | |
| | WML | **-0.23** | **-0.32** | **-0.51** | |
| | Liquidity (Lt) | 0.09 | 0.13 | 0.10 | -0.04 |
| NETHERLANDS | SMB | **0.54** | | | |
| | HML | **0.20** | 0.04 | | |
| | WML | 0.11 | -0.05 | **-0.30** | |
| | Liquidity (Lt) | 0.04 | -0.01 | -0.05 | 0.05 |
| NEW ZEALAND | SMB | **0.37** | | | |
| | HML | -0.04 | 0.07 | | |
| | WML | **-0.25** | -0.01 | **-0.19** | |
| | Liquidity (Lt) | **0.17** | -0.05 | -0.08 | 0.03 |
| NORWAY | SMB | **0.59** | | | |
| | HML | **0.17** | -0.04 | | |
| | WML | -0.04 | 0.09 | -0.05 | |
| | Liquidity (Lt) | 0.09 | 0.04 | 0.05 | 0.09 |
| SINGAPORE | SMB | 0.12 | | | |
| | HML | **0.34** | **-0.25** | | |
| | WML | **-0.17** | **-0.16** | **-0.40** | |
| | Liquidity (Lt) | **0.15** | -0.02 | 0.12 | -0.01 |
| SPAIN | SMB | 0.09 | | | |
| | HML | **-0.25** | 0.00 | | |
| | WML | **0.16** | -0.09 | **-0.21** | |
| | Liquidity (Lt) | **0.24** | -0.04 | -0.14 | **0.17** |
| SWEDEN | SMB | **0.23** | | | |
| | HML | -0.07 | -0.03 | | |
| | WML | -0.02 | -0.06 | **-0.40** | |
| | Liquidity (Lt) | -0.01 | 0.13 | 0.07 | 0.00 |
| SWITZERLAND | SMB | **0.65** | | | |
| | HML | 0.10 | -0.06 | | |
| | WML | **0.35** | **-0.30** | -0.12 | |
| | Liquidity (Lt) | **0.19** | 0.13 | **0.20** | 0.09 |
| UK | SMB | **0.52** | | | |
| | HML | 0.07 | -0.13 | | |
| | WML | -0.05 | **0.31** | **-0.49** | |
| | Liquidity (Lt) | **0.24** | **0.17** | 0.00 | -0.14 |
| US | SMB | **0.30** | | | |
| | HML | **-0.42** | **-0.29** | | |
| | MOM | 0.01 | 0.03 | **-0.19** | |
| | Liquidity (Lt) | **0.34** | **0.20** | **-0.11** | 0.09 |

## Table 3.4

## Correlation of U.S. Market Liquidity with Foreign Purchases of U.S. Treasuries In Months with Large Liquidity Drops

The table reports the correlation of the market liquidity for the U.S. equity market and foreign purchases of U.S. Treasuries during months of "low liquidity". "Low-liquidity" months are those in which the market liquidity for the U.S. is at least two standard deviations away below its mean. Liquidity shown in the figure is standardized using its standard deviation and mean of each year. The same standardization is applied to foreign purchases of U.S. Treasuries, which is the total purchase of U.S. treasuries recorded as cross-border transactions of the 18 countries other than the U.S. in our sample. The p-value is for the hypothesis that the correlation is statistically not different from zero.

| | Correlation of Liquidity with foreign purchases of U.S. Treasuries | *P*-value under $H_0$: Correlation = 0 | No. of observations |
|---|---|---|---|
| | Jan 1977 - Jun 2001 | | |
| All months | -0.063 | 0.284 | 294 |
| Low-liquidity months (by 2 std. dev.'s) | -0.515 | 0.059 | 14 |
| Other months | -0.028 | 0.636 | 280 |
| | | | |
| | Jan 1977 - Dec 1989 | | |
| All months | -0.040 | 0.623 | 157 |
| Low-liquidity months (by 2 std. dev.'s) | -0.309 | 0.500 | 7 |
| Other months | 0.012 | 0.886 | 150 |
| | | | |
| | Jan 1990 - Jun 2001 | | |
| All months | -0.089 | 0.299 | 137 |
| Low-liquidity months (by 2 std. dev.'s) | -0.752 | 0.051 | 7 |
| Other months | 0.075 | 0.399 | 130 |

## Table 3.5

## Determinants of Predicted Liquidity Betas

For each country, each column reports the results of estimating a linear relation between a stock's liquidity beta and the seven characteristics listed (in addition to the intercept, shown first). At each year-end, the estimation uses all stocks defined as ordinary common shares traded on the largest stock exchange of a given country with at least three years of monthly returns continuing through the given year-end. The estimation uses a two-state pooled time-series and cross-sectional approach. Each value reported is equal to the coefficient estimate multiplied by the time-series average of the annual cross-sectional standard deviations of the characteristic. The t-statistics are in parentheses.

| Country | Intercept | Historical beta | Average liquidity | Price | Shares outstanding | Average volume | Return volatility | Cumulative return |
|---|---|---|---|---|---|---|---|---|
| AUSTRALIA | 0.55 | 1.29 | -5.56 | 0.73 | 0.55 | -0.85 | 2.13 | -0.48 |
| | (-2.66) | (1.65) | (-1.37) | (5.43) | (1.42) | (-2.50) | (1.61) | (-0.91) |
| AUSTRIA | 5.28 | 1.11 | -2.35 | -1.80 | 2.33 | -5.62 | 5.60 | -3.05 |
| | (1.80) | (0.17) | (-1.49) | (-0.92) | (0.85) | (-2.35) | (1.15) | (-1.19) |
| BELGIUM | 1.17 | -0.36 | 5.61 | 1.80 | -0.32 | 0.57 | 3.15 | -9.58 |
| | (1.66) | (-1.44) | (1.02) | (1.44) | (-0.36) | (0.59) | (1.52) | (-2.08) |
| CANADA | 0.15 | 1.10 | 0.85 | 0.39 | 0.16 | -0.26 | 0.52 | -0.24 |
| | (3.68) | (9.64) | (1.25) | (3.19) | (2.49) | (-3.67) | (3.50) | (-2.77) |
| DENMARK | -1.50 | 3.43 | 2.79 | 5.89 | 2.20 | -0.36 | -2.42 | 2.27 |
| | (-1.69) | (1.65) | (2.01) | (2.41) | (2.09) | (-0.75) | (-2.26) | (1.74) |
| FRANCE | 1.82 | 4.81 | 1.24 | -1.27 | 1.03 | -0.64 | -4.05 | 3.50 |
| | (0.20) | (1.68) | (1.29) | (-1.45) | (1.66) | (-1.78) | (-0.62) | (0.26) |
| GERMANY | 1.17 | 1.88 | -2.34 | -2.70 | 4.19 | -6.57 | -7.27 | 3.92 |
| | (2.26) | (1.83) | (-2.07) | (-2.77) | (1.32) | (-1.09) | (-1.52) | (0.40) |
| HONG KONG | -2.24 | 2.12 | -9.72 | -2.97 | 0.22 | 2.37 | -3.08 | 7.35 |
| | (-0.62) | (3.25) | (-1.87) | (-1.28) | (0.12) | (1.27) | (-2.33) | (2.29) |

**Table 3.5 – Continued**

| Country | Intercept | Historical beta | Average liquidity | Price | Shares outstanding | Average volume | Return volatility | Cumulative return |
|---|---|---|---|---|---|---|---|---|
| ITALY | -0.27 | 0.35 | 12.33 | 2.06 | 2.06 | -2.15 | 0.78 | -1.20 |
| | (-0.68) | (1.92) | (1.57) | (2.83) | (1.96) | (-2.78) | (0.84) | (-2.96) |
| JAPAN | -4.82 | -0.12 | 1.26 | 5.10 | 6.97 | -10.59 | 1.12 | -0.63 |
| | (-2.61) | (-0.16) | (2.29) | (2.25) | (2.93) | (-2.98) | (0.61) | (-0.33) |
| NETHERLANDS | -3.73 | 3.01 | -2.03 | 1.75 | 1.38 | -1.08 | 0.84 | -0.90 |
| | (-4.16) | (5.47) | (-1.03) | (4.09) | (5.48) | (-3.49) | (3.61) | (-2.52) |
| NEW ZEALAND | 0.15 | -0.05 | -0.28 | 3.01 | 4.32 | -4.26 | -0.30 | -0.14 |
| | (0.11) | (-0.62) | (-0.28) | (3.92) | (2.35) | (-3.23) | (-0.28) | (-0.19) |
| NORWAY | 19.04 | -0.15 | 0.81 | 7.88 | -12.46 | 2.69 | -1.79 | 2.37 |
| | (1.73) | (-0.03) | (0.04) | (2.28) | (-2.50) | (5.49) | (-0.35) | (5.27) |
| SINGAPORE | 13.63 | 1.36 | 0.58 | -5.15 | -4.59 | 0.96 | -5.43 | 0.70 |
| | (4.67) | (1.92) | (16.75) | (-5.06) | (-5.05) | (0.73) | (-3.95) | (0.78) |
| SPAIN | -5.15 | 3.20 | 1.01 | -4.03 | 3.34 | -5.48 | 0.61 | 4.17 |
| | (-3.12) | (2.18) | (7.44) | (-2.64) | (2.58) | (-3.83) | (0.58) | (3.48) |
| SWEDEN | -3.70 | 5.81 | -0.48 | -8.98 | -4.14 | 7.37 | -5.64 | -0.35 |
| | (-2.31) | (5.55) | (-0.41) | (-3.25) | (-1.68) | (1.37) | (-2.05) | (-0.21) |
| SWITZERLAND | 2.45 | 0.35 | 0.40 | -2.65 | -0.17 | -0.42 | -1.40 | 2.23 |
| | (4.01) | (0.64) | (0.14) | (-1.67) | (-0.47) | (-1.29) | (-0.95) | (3.21) |
| UK | -1.72 | 3.47 | -4.94 | -1.64 | 2.55 | 12.05 | 6.44 | 0.16 |
| | (-3.52) | (2.14) | (-1.52) | (-2.10) | (0.43) | (1.70) | (1.32) | (1.78) |
| US | -1.31 | 5.23 | 0.40 | 3.76 | 2.34 | -6.85 | -1.17 | -0.15 |
| | (-7.21) | (11.07) | (8.23) | (15.35) | (10.43) | (-19.70) | (-8.09) | (-1.07) |

**Table 3.6**

**Post-Ranking Liquidity Betas of Portfolios Sorted on Predicted Liquidity Betas**

For each country, at each year-end between three years after the start year and 2000, eligible stocks are sorted into 10 portfolios cording to their predicted liquidity betas. The betas are constructed as linear functions of seven stock characteristics at the current year-end, using coefficients estimated from a pooled time-series cross-sectional regression approach. The estimation and sorting procedure at each year-end uses only data available at that time. Eligible stocks are defined as ordinary common shares traded on the largest stock exchange with at least three years of monthly returns continuing through the current year-end and with stock prices above the five percentile of each country. The portfolio returns for the 12 post-ranking months are linked across years to form one series of post-ranking returns for each decile. The table reports the decile portfolio's post-ranking liquidity betas, estimated by regressing the value-weighted portfolio excess returns on the aggregate liquidity innovation and the Fama-French factors.

| **Country** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **10-1** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AUSTRALIA | -4.07 | -4.09 | -5.98 | -1.05 | -3.82 | -2.15 | 2.95 | 1.60 | 0.79 | 2.36 | 6.43 |
| | (-2.77) | (-1.72) | (-1.36) | (-1.25) | (-2.28) | (-1.39) | (0.10) | (0.99) | (0.06) | (2.22) | (1.97) |
| AUSTRIA | -1.60 | -1.00 | -2.83 | 1.94 | 1.34 | 1.44 | 2.96 | 0.80 | 3.14 | 1.63 | 3.23 |
| | (-2.74) | (-2.05) | (1.71) | (1.75) | (0.76) | (0.55) | (2.12) | (0.49) | (1.37) | (1.27) | (0.98) |
| BELGIUM | -2.04 | -2.51 | -2.29 | 1.86 | 3.78 | 3.38 | 4.55 | 2.68 | 1.83 | 1.26 | 3.31 |
| | (-2.19) | (-0.28) | (-1.39) | (1.28) | (0.50) | (1.00) | (0.44) | (2.25) | (2.12) | (0.37) | (0.48) |
| CANADA | -4.53 | -3.50 | -2.09 | -2.97 | -2.38 | -0.60 | -1.15 | 1.34 | 1.18 | 1.56 | 6.09 |
| | (-2.46) | (-1.77) | (-2.59) | (-0.91) | (-2.22) | (-0.38) | (-0.18) | (2.54) | (1.43) | (0.22) | (2.16) |
| DENMARK | -3.30 | -4.46 | -3.62 | -0.07 | 0.24 | 0.14 | 1.42 | 0.67 | 1.27 | 0.96 | 4.26 |
| | (-1.93) | (-0.31) | (-1.62) | (-0.37) | (1.37) | (1.57) | (0.24) | (1.89) | (1.46) | (1.81) | (0.78) |
| FRANCE | -5.63 | -3.68 | -4.89 | -3.29 | -3.95 | -1.06 | -0.90 | 1.70 | 1.46 | 1.37 | 7.00 |
| | (-1.29) | (-0.03) | (-2.21) | (-0.62) | (-0.53) | (-1.62) | (-0.54) | (1.58) | (1.28) | (2.24) | (3.28) |
| GERMANY | -3.44 | -3.05 | -1.72 | -0.18 | -1.10 | 0.26 | -1.58 | 1.86 | 1.92 | 2.12 | 5.56 |
| | (-0.85) | (-1.31) | (-0.33) | (-0.30) | (-0.98) | (2.63) | (-0.49) | (0.98) | (2.18) | (2.43) | (2.93) |
| HONG KONG | -3.94 | -4.84 | -3.31 | -2.93 | -2.01 | -1.18 | -1.53 | 0.65 | 1.13 | 0.58 | 4.52 |
| | (-2.68) | (-0.96) | (-0.16) | (-0.83) | (-2.33) | (-2.51) | (-0.19) | (2.01) | (1.90) | (0.07) | (2.24) |

## Table 3.6 – Continued

| Country | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ITALY | -4.25 | -6.11 | -5.91 | -2.35 | -4.39 | -4.05 | -2.57 | -0.67 | 1.29 | 1.69 | 5.94 |
| | (-1.14) | (-2.67) | (-0.05) | (-1.01) | (-2.86) | (-0.19) | (-0.76) | (-2.15) | (0.70) | (2.71) | (0.89) |
| JAPAN | -5.98 | -6.91 | -6.77 | -5.16 | -5.62 | -5.96 | -4.33 | -2.53 | 0.30 | 1.80 | 7.78 |
| | (-0.95) | (-1.80) | (-0.18) | (-0.99) | (-2.09) | (-2.95) | (-2.37) | (-0.00) | (0.04) | (0.03) | (2.32) |
| NETHERLANDS | -2.53 | -4.40 | -4.81 | -3.13 | -3.23 | -3.58 | 1.02 | 1.46 | 2.61 | 0.91 | 3.44 |
| | (-0.11) | (-1.20) | (-2.41) | (-2.64) | (-1.55) | (-0.94) | (1.16) | (2.83) | (2.01) | (1.60) | (1.94) |
| NEW ZEALAND | -3.24 | -1.82 | -4.62 | -2.64 | -2.79 | -0.38 | 1.20 | 2.39 | 1.28 | 1.31 | 4.56 |
| | (-1.19) | (-1.15) | (-0.66) | (-1.23) | (-1.36) | (-2.40) | (1.42) | (1.49) | (1.41) | (0.04) | (1.04) |
| NORWAY | -3.15 | -3.89 | -2.28 | -2.78 | -1.04 | 0.26 | -1.50 | 0.60 | 0.90 | 1.19 | 4.34 |
| | (-0.76) | (-2.44) | (-1.07) | (-2.93) | (-1.08) | (2.30) | (-2.76) | (1.98) | (2.69) | (0.37) | (0.97) |
| SINGAPORE | -4.64 | -3.13 | -2.17 | -1.96 | -2.11 | -1.13 | 1.20 | 0.52 | 0.78 | 1.83 | 6.47 |
| | (-1.35) | (-1.27) | (-1.61) | (-1.70) | (-2.39) | (-0.62) | (1.43) | (2.25) | (0.66) | (1.34) | (3.14) |
| SPAIN | -4.54 | -3.10 | -2.52 | -1.81 | -1.35 | -2.81 | -1.89 | -1.48 | -1.83 | -0.58 | 3.96 |
| | (-2.54) | (-1.84) | (-0.19) | (-0.00) | (-2.62) | (-1.03) | (-0.46) | (-1.04) | (-2.19) | (0.03) | (1.10) |
| SWEDEN | -2.20 | -1.32 | -1.61 | -0.11 | -0.17 | 0.74 | 1.84 | 1.80 | 2.01 | 1.79 | 3.99 |
| | (-2.43) | (-1.81) | (-0.53) | (-0.17) | -(1.76) | (1.12) | (0.00) | (0.92) | (0.50) | (1.56) | (1.57) |
| SWITZERLAND | -4.13 | -3.89 | -2.60 | 0.54 | -1.99 | 0.31 | 0.96 | 1.90 | 1.74 | 1.57 | 5.70 |
| | (-0.35) | (-2.12) | (-2.35) | (0.38) | (-0.94) | (1.75) | (1.67) | (1.50) | (1.85) | (1.87) | (1.33) |
| UK | -4.31 | -5.79 | -4.69 | -4.39 | -2.88 | -2.34 | 0.72 | 0.38 | 1.10 | 2.15 | 6.46 |
| | (-1.02) | (-2.30) | (-2.94) | (-2.04) | (-1.22) | (-0.15) | (0.92) | (2.28) | (2.85) | (2.18) | (3.07) |
| US | -5.63 | -6.84 | -5.31 | -3.34 | 1.26 | 0.31 | 1.01 | 1.14 | 2.28 | 2.85 | 8.48 |
| | (-2.36) | (-2.23) | (-1.89) | (2.17) | (0.98) | (0.80) | (0.94) | (0.74) | (1.69) | (1.02) | (3.29) |

## Table 3.7

### Alphas of Value-Weighted Portfolios Sorted on Predicted Liquidity Betas

For each country, at each year-end between three years after the start year and 2000, eligible stocks are sorted into 10 portfolios cording to their predicted liquidity betas. The betas are constructed as linear functions of seven stock characteristics at the current year-end, using coefficients estimated from a pooled time-series cross-sectional regression approach. The estimation and sorting procedure at each year-end uses only data available at that time. Eligible stocks are defined as ordinary common shares traded on the largest stock exchange with at least three years of monthly returns continuing through the current year-end and with stock prices above the five percentile of each country. The portfolio returns for the 12 post-ranking months are linked across years to form one series of post-ranking returns for each decile. The table reports the decile portfolio's post-ranking alphas, in percent per year. The alphas are estimated as intercepts from the regressions of excess portfolio post-ranking returns on excess market returns (CAPM alpha), on the Fama-French factor returns (Fama-French alpha), and on the Fama-French and momentum factor returns (4-factor alpha). The t-statistics are in parentheses.

| country | Model | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUSTRALIA | CAPM alpha | -1.35 | -2.18 | 0.45 | -0.14 | 2.40 | 0.52 | 1.73 | -3.60 | -1.81 | -0.86 | 0.49 |
| | | (-1.35) | (-0.48) | (1.29) | (-0.04) | (0.68) | (0.14) | (0.46) | (-0.84) | (-0.38) | (-0.13) | (-1.25) |
| | Fama-French alpha | -0.04 | -3.67 | 0.84 | -4.19 | -1.58 | -2.39 | -2.00 | -1.44 | -1.80 | -1.65 | -1.62 |
| | | (-0.01) | (-0.99) | (0.23) | (-1.24) | (-0.55) | (-0.75) | (-0.66) | (-2.40) | (-1.84) | (-1.41) | (-1.06) |
| | 4-factor alpha | 1.35 | -5.43 | -1.13 | -3.97 | -3.03 | -2.49 | -0.70 | -1.89 | -1.81 | -1.34 | -2.69 |
| | | (0.24) | (-1.39) | (-0.29) | (-1.10) | (-1.01) | (-0.73) | (-0.22) | (-1.59) | (-1.23) | (-1.44) | (-1.27) |
| AUSTRIA | CAPM alpha | 0.02 | 0.20 | -1.00 | 5.02 | -6.44 | -6.29 | 1.62 | -3.88 | -1.17 | -0.60 | -0.62 |
| | | (0.01) | (0.05) | (-0.26) | (1.16) | (-1.72) | (-1.42) | (0.31) | (-0.90) | (-0.21) | (-1.63) | (-1.08) |
| | Fama-French alpha | 1.31 | -2.17 | -1.93 | 3.20 | -5.80 | -5.54 | 1.80 | -5.09 | 0.74 | -0.03 | -1.34 |
| | | (0.28) | (-0.47) | (-0.47) | (0.76) | (-1.54) | (-1.22) | (0.34) | (-1.12) | (0.13) | (-1.20) | (-0.98) |
| | 4-factor alpha | 1.32 | -2.14 | -1.90 | 3.19 | -5.81 | -5.57 | 1.75 | -5.09 | 0.70 | -0.05 | -1.37 |
| | | (0.28) | (-0.47) | (-0.48) | (0.75) | (-1.53) | (-1.25) | (0.35) | (-1.12) | (0.13) | (-1.21) | (-1.00) |
| BELGIUM | CAPM alpha | 2.09 | 4.57 | 4.78 | -6.11 | 4.87 | -8.52 | -9.56 | -9.37 | -0.49 | -8.85 | -10.94 |
| | | (2.03) | (0.38) | (1.55) | (-1.00) | (0.64) | (-1.95) | (-0.92) | (-0.82) | (-0.04) | (-0.53) | (-1.03) |
| | Fama-French alpha | 1.74 | 2.38 | 4.55 | -6.49 | 0.81 | -7.33 | -6.95 | -6.24 | -1.92 | -6.72 | -8.46 |
| | | (1.14) | (1.63) | (0.56) | (-0.87) | (0.09) | (-0.74) | (-1.02) | (-0.48) | (-0.36) | (0.83) | (-1.38) |
| | 4-factor alpha | 0.97 | 1.49 | 4.87 | -3.57 | 4.26 | -5.19 | -7.32 | 1.05 | -3.25 | -5.97 | -6.94 |
| | | (1.02) | (1.35) | (0.73) | (-0.45) | (0.43) | (-0.48) | (-0.54) | (0.08) | (-0.23) | (-0.28) | (-1.02) |

**Table 3.7 – Continued**

| country | Model | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CANADA | CAPM alpha | 1.22 | 3.98 | 2.60 | 1.15 | -5.46 | -1.89 | -0.36 | 1.98 | 2.83 | 4.84 | 3.62 |
| | | (0.94) | (2.78) | (1.09) | (0.52) | (-2.10) | (-0.85) | (-0.50) | (1.34) | (0.22) | (0.74) | (0.14) |
| | Fama-French alpha | 0.97 | 4.30 | 0.17 | -0.65 | -0.65 | -0.26 | 1.06 | 1.59 | 3.71 | 3.06 | 2.08 |
| | | (0.32) | (1.92) | (0.08) | (-0.31) | (-3.79) | (-2.11) | (2.19) | (2.92) | (1.87) | (0.73) | (0.49) |
| | 4-factor alpha | -0.76 | 1.23 | 0.79 | 0.21 | -0.99 | 1.95 | 3.73 | 4.80 | 3.04 | 3.41 | 4.17 |
| | | (-0.24) | (2.20) | (0.34) | (0.09) | (-3.30) | (1.39) | (1.53) | (1.77) | (0.95) | (0.55) | (0.37) |
| DENMARK | CAPM alpha | -5.58 | -3.36 | -1.07 | -1.67 | 2.32 | 1.35 | 2.13 | 3.07 | 2.62 | 1.92 | 7.50 |
| | | (-0.41) | (-0.25) | (-1.92) | (-2.40) | (0.27) | (0.22) | (1.07) | (0.59) | (0.99) | (0.21) | (1.10) |
| | Fama-French alpha | -4.03 | -2.87 | 1.59 | -1.81 | -0.31 | -1.33 | -1.59 | -1.84 | -1.58 | -0.37 | 3.66 |
| | | (-0.29) | (-0.22) | (1.48) | (-2.20) | (-0.42) | (-0.22) | (-1.06) | (-1.03) | (-1.16) | (-0.46) | (0.94) |
| | 4-factor alpha | -3.27 | -2.47 | 1.67 | -1.34 | -1.20 | -2.29 | -0.02 | -1.50 | -0.55 | 1.56 | 4.84 |
| | | (-0.23) | (-0.66) | (1.80) | (-2.07) | (-0.09) | (-0.34) | (-0.00) | (-1.38) | (-1.01) | (0.15) | (1.31) |
| FRANCE | CAPM alpha | 1.76 | 1.65 | 3.40 | 3.11 | 1.44 | 1.47 | 0.83 | 5.54 | 4.71 | 3.44 | 1.68 |
| | | (1.64) | (0.24) | (0.70) | (0.82) | (2.22) | (2.31) | (0.21) | (1.40) | (1.31) | (0.67) | (0.88) |
| | Fama-French alpha | 1.21 | 3.91 | 4.71 | 2.15 | 3.27 | 2.54 | 0.79 | 5.21 | 3.92 | 6.35 | 5.13 |
| | | (2.53) | (0.58) | (1.00) | (0.31) | (2.68) | (2.65) | (0.20) | (1.35) | (1.70) | (1.26) | (1.19) |
| | 4-factor alpha | 1.36 | 3.19 | 4.27 | 2.25 | 1.89 | 2.10 | 3.25 | 4.36 | 4.06 | 5.26 | 3.90 |
| | | (1.89) | (0.45) | (1.27) | (0.59) | (2.87) | (2.85) | (0.81) | (1.85) | (1.79) | (2.61) | (1.01) |
| GERMANY | CAPM alpha | -8.25 | -2.36 | -3.38 | -2.73 | -5.64 | -3.62 | -1.88 | -1.23 | -1.46 | 1.07 | 9.32 |
| | | (-2.12) | (-0.69) | (-0.93) | (-0.80) | (-1.63) | (-1.04) | (-0.58) | (-0.34) | (-0.38) | (0.29) | (2.06) |
| | Fama-French alpha | -6.91 | -1.64 | -2.07 | -3.21 | -5.58 | -3.13 | -2.67 | -1.18 | -0.43 | 1.68 | 8.59 |
| | | (-1.70) | (-0.47) | (-0.56) | (-0.91) | (-1.53) | (-0.87) | (-0.88) | (-0.35) | (-0.11) | (0.47) | (1.84) |
| | 4-factor alpha | -5.46 | 0.63 | 0.40 | -1.77 | -3.61 | -1.34 | -0.54 | 0.43 | 2.94 | 4.39 | 9.85 |
| | | (-1.34) | (0.18) | (0.11) | (-0.50) | (-1.00) | (-0.38) | (-0.18) | (0.13) | (0.81) | (1.29) | (2.08) |

## Table 3.7 – Continued

| country | Model | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HONG KONG | CAPM alpha | -5.44 | 3.50 | 0.76 | -2.20 | 0.79 | 1.75 | 3.89 | -0.35 | 3.05 | 4.86 | 10.30 |
| | | (-0.61) | (0.42) | (0.10) | (-0.29) | (0.10) | (0.20) | (0.41) | (-0.03) | (0.28) | (0.50) | (1.01) |
| | Fama-French alpha | -7.84 | 0.84 | -1.57 | -4.30 | -1.58 | -1.96 | 0.32 | -4.22 | 0.19 | 1.18 | 9.02 |
| | | (-1.16) | (0.14) | (-0.34) | (-0.81) | (-0.29) | (-0.34) | (0.05) | (-0.58) | (0.02) | (0.13) | (0.80) |
| | 4-factor alpha | -6.45 | 1.90 | -0.98 | -3.44 | -0.80 | -1.35 | 0.10 | -4.28 | -0.34 | 1.25 | 7.70 |
| | | (-0.97) | (0.33) | (-0.21) | (-0.65) | (-0.15) | (-0.23) | (0.02) | (-0.58) | (-0.04) | (0.14) | (0.68) |
| | | | | | | | | | | | | |
| ITALY | CAPM alpha | -3.50 | -3.52 | -1.66 | 0.99 | 0.31 | -0.37 | 3.29 | 3.14 | 2.57 | 3.62 | 7.12 |
| | | (-1.26) | (-0.72) | (-0.12) | (0.23) | (1.06) | (-0.08) | (1.57) | (1.11) | (0.47) | (0.63) | (1.48) |
| | Fama-French alpha | -3.77 | -3.39 | -1.88 | 0.69 | 1.05 | -0.80 | 2.02 | 2.19 | 2.79 | 3.80 | 7.57 |
| | | (-1.79) | (-0.74) | (-0.18) | (0.18) | (1.07) | (-0.21) | (1.74) | (1.43) | (0.55) | (0.72) | (1.55) |
| | 4-factor alpha | -4.01 | -4.15 | -2.90 | -1.86 | 1.79 | 3.56 | 3.16 | 2.90 | 1.16 | 3.24 | 7.25 |
| | | (1.53) | (0.89) | (1.31) | (1.19) | (2.07) | (1.75) | (1.41) | (1.57) | (1.75) | (2.32) | (1.56) |
| | | | | | | | | | | | | |
| | | (-1.04) | (-0.85) | (-0.19) | (-0.44) | (1.02) | (0.78) | (1.38) | (1.07) | (0.03) | (1.09) | (1.44) |
| JAPAN | CAPM alpha | -10.10 | -6.52 | -3.99 | -2.55 | -1.68 | -2.29 | 2.00 | -0.44 | 0.31 | -0.13 | 9.96 |
| | | (-1.30) | (-0.96) | (-0.61) | (-0.44) | (-0.25) | (-0.36) | (0.31) | (-0.06) | (0.04) | (-0.02) | (1.10) |
| | Fama-French alpha | -9.72 | -7.12 | -6.14 | -4.20 | -4.21 | -4.34 | 0.33 | -1.89 | -1.96 | -3.58 | 6.14 |
| | | (-1.52) | (-1.39) | (-1.39) | (-1.17) | (-1.15) | (-1.36) | (0.11) | (-0.64) | (-0.59) | (-0.80) | (0.68) |
| | 4-factor alpha | -8.68 | -5.65 | -5.00 | -2.84 | -2.88 | -2.86 | 1.44 | -0.70 | -0.43 | -2.41 | 6.27 |
| | | (-1.36) | (-1.13) | (-1.15) | (-0.83) | (-0.83) | (-0.98) | (0.51) | (-0.25) | (-0.14) | (-0.55) | (0.68) |
| | | | | | | | | | | | | |
| NETHERLANDS | CAPM alpha | -9.05 | -1.32 | 3.60 | 1.63 | -0.31 | -0.60 | 1.34 | -1.91 | 1.53 | -4.35 | 4.71 |
| | | (-2.15) | (-0.43) | (1.11) | (0.53) | (-0.11) | (-0.19) | (0.43) | (-0.58) | (0.47) | (-1.14) | (0.98) |
| | Fama-French alpha | -6.93 | 0.24 | 5.32 | 2.86 | 0.77 | 0.95 | 2.89 | -0.82 | 2.95 | -2.33 | 4.61 |
| | | (-1.80) | (0.08) | (1.83) | (0.96) | (0.27) | (0.33) | (1.00) | (-0.26) | (0.98) | (-0.66) | (0.95) |
| | 4-factor alpha | -4.33 | -0.03 | 6.93 | 2.39 | 1.58 | 2.34 | 4.38 | -0.51 | 3.64 | -3.63 | 0.70 |
| | | (-1.12) | (-0.01) | (2.36) | (0.78) | (0.55) | (0.80) | (1.49) | (-0.16) | (1.17) | (-1.00) | (0.15) |

**Table 3.7 – Continued**

| country | Model | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEW ZEALAND | CAPM alpha | 5.43 | 0.12 | -2.69 | -1.07 | -6.16 | -1.82 | -4.97 | 0.76 | 10.28 | 12.97 | 7.54 |
| | | (0.62) | (0.02) | (-0.34) | (-0.19) | (-1.03) | (-0.28) | (-0.84) | (0.14) | (1.89) | (1.90) | (0.81) |
| | Fama-French alpha | 9.24 | 1.02 | 0.14 | -0.57 | -5.15 | -1.33 | -4.48 | -0.04 | 9.82 | 15.38 | 6.14 |
| | | (1.08) | (0.16) | (0.02) | (-0.10) | (-0.85) | (-0.20) | (-0.75) | (-0.01) | (1.79) | (2.27) | (0.64) |
| | 4-factor alpha | 4.72 | 2.03 | 1.88 | -3.12 | -7.69 | -0.36 | -1.75 | -2.64 | 9.66 | 10.20 | 5.48 |
| | | (0.53) | (0.31) | (0.23) | (-0.54) | (-1.21) | (-0.05) | (-0.28) | (-0.47) | (1.67) | (1.47) | (0.54) |
| | | | | | | | | | | | | |
| NORWAY | CAPM alpha | 3.08 | 3.70 | 2.13 | 0.05 | -0.21 | 3.67 | -0.08 | -5.91 | -4.94 | 5.53 | 2.45 |
| | | (0.32) | (2.07) | (1.16) | (0.01) | (-0.05) | (0.62) | (-0.01) | (-1.10) | (-1.18) | (1.04) | (0.25) |
| | Fama-French alpha | -1.64 | 8.41 | 2.72 | -3.42 | -0.79 | 0.97 | -0.66 | -3.10 | -0.77 | 3.98 | 5.62 |
| | | (-0.91) | (1.35) | (0.42) | (-0.64) | (-0.17) | (0.17) | (-0.12) | (-1.30) | (-1.14) | (0.74) | (1.29) |
| | 4-factor alpha | -3.64 | 8.41 | 2.72 | -3.41 | -0.80 | 0.97 | -0.66 | -2.10 | -1.77 | 3.99 | 7.63 |
| | | (-0.91) | (1.34) | (0.42) | (-0.65) | (-0.17) | (0.17) | (-0.12) | (-1.29) | (-1.15) | (0.74) | (1.29) |
| | | | | | | | | | | | | |
| SINGAPORE | CAPM alpha | 4.04 | 3.74 | 7.19 | 0.04 | 2.34 | 3.06 | 2.82 | 1.01 | 4.99 | 6.02 | 1.98 |
| | | (1.07) | (0.92) | (1.61) | (0.01) | (0.56) | (0.66) | (0.64) | (0.18) | (0.87) | (0.88) | (0.29) |
| | Fama-French alpha | 2.67 | 1.69 | 5.02 | -2.45 | -0.31 | 0.43 | 0.64 | -2.16 | 1.99 | 2.41 | -0.26 |
| | | (0.78) | (0.50) | (1.35) | (-0.64) | (-0.10) | (0.13) | (0.18) | (-0.54) | (0.51) | (0.51) | (-0.04) |
| | 4-factor alpha | 2.35 | 1.75 | 5.23 | -1.93 | 0.03 | 0.81 | 1.19 | -1.54 | 2.31 | 2.85 | 0.50 |
| | | (0.70) | (0.52) | (1.42) | (-0.53) | (0.01) | (0.26) | (0.37) | (-0.41) | (0.61) | (0.62) | (0.09) |
| | | | | | | | | | | | | |
| SPAIN | CAPM alpha | 4.37 | -1.58 | 0.56 | 0.81 | 6.12 | 1.37 | 2.27 | 0.43 | 7.76 | 8.01 | 3.64 |
| | | (0.76) | (-0.28) | (0.10) | (0.17) | (0.98) | (0.23) | (0.38) | (0.07) | (1.18) | (1.92) | (1.04) |
| | Fama-French alpha | 2.42 | -3.14 | -3.07 | 0.75 | 3.80 | 2.14 | 2.63 | 1.35 | 6.42 | 8.14 | 5.73 |
| | | (0.47) | (-0.60) | (-0.61) | (0.18) | (0.70) | (0.41) | (0.53) | (0.28) | (1.24) | (2.53) | (1.52) |
| | 4-factor alpha | 3.33 | -0.95 | -2.08 | 0.94 | 4.97 | 4.11 | 2.16 | 2.78 | 7.52 | 9.03 | 5.70 |
| | | (0.66) | (-0.20) | (-0.41) | (0.22) | (0.92) | (0.85) | (0.43) | (0.60) | (1.47) | (2.70) | (1.50) |

**Table 3.7 – Continued**

| country | Model | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWEDEN | CAPM alpha | 1.22 | 8.35 | -3.16 | 2.26 | 0.65 | 2.86 | 2.27 | 4.05 | 3.89 | 5.95 | 4.73 |
| | | (0.13) | (1.07) | (-0.60) | (0.45) | (0.13) | (0.70) | (0.42) | (0.74) | (0.70) | (2.66) | (2.07) |
| | Fama-French alpha | 0.90 | 6.84 | -3.79 | 1.39 | -0.62 | 1.74 | 1.54 | 3.29 | 3.33 | 6.34 | 5.44 |
| | | (0.12) | (1.18) | (-0.83) | (0.32) | (-0.16) | (0.54) | (0.32) | (0.76) | (0.65) | (3.37) | (2.03) |
| | 4-factor alpha | -0.34 | 3.78 | -3.78 | 3.11 | 1.07 | 3.05 | 3.65 | 7.06 | 5.15 | 7.34 | 7.67 |
| | | (-0.04) | (0.66) | (-0.80) | (0.71) | (0.28) | (0.95) | (0.75) | (1.75) | (1.00) | (4.20) | (2.64) |
| | | | | | | | | | | | | |
| SWITZERLAND | CAPM alpha | -0.69 | -0.42 | -1.73 | 4.59 | 4.02 | 4.19 | 1.40 | -0.17 | -1.05 | 8.59 | 9.29 |
| | | (-0.13) | (-0.10) | (-0.49) | (1.18) | (0.96) | (1.07) | (0.39) | (-0.05) | (-0.17) | (1.27) | (1.45) |
| | Fama-French alpha | -2.74 | -1.47 | -3.00 | 3.34 | 2.84 | 2.74 | 0.45 | -1.22 | -3.21 | 6.01 | 8.75 |
| | | (-0.55) | (-0.35) | (-0.91) | (0.90) | (0.70) | (0.74) | (0.13) | (-0.35) | (-0.56) | (0.97) | (1.88) |
| | 4-factor alpha | -2.30 | -1.13 | -2.87 | 3.04 | 2.37 | 2.40 | 0.25 | -1.54 | -4.36 | 4.87 | 7.17 |
| | | (-0.46) | (-0.27) | (-0.86) | (0.82) | (0.59) | (0.65) | (0.07) | (-0.44) | (-0.79) | (0.81) | (1.79) |
| | | | | | | | | | | | | |
| UK | CAPM alpha | -6.40 | 3.41 | -0.81 | -0.70 | -4.85 | 1.52 | -2.58 | 3.50 | 1.37 | 6.44 | 12.84 |
| | | (-1.05) | (0.87) | (-0.20) | (-0.22) | (-1.32) | (0.47) | (-0.95) | (1.34) | (0.56) | (1.58) | (2.31) |
| | Fama-French alpha | -1.73 | 4.24 | -0.73 | -0.29 | -4.60 | 1.50 | -3.11 | 3.21 | 2.15 | 9.08 | 10.81 |
| | | (-0.30) | (1.11) | (-0.19) | (-0.09) | (-1.31) | (0.46) | (-1.16) | (1.26) | (0.95) | (2.30) | (1.93) |
| | 4-factor alpha | -8.30 | 1.84 | -3.51 | -0.54 | -6.52 | 1.03 | -4.14 | 3.00 | 3.00 | 6.16 | 14.46 |
| | | (-1.25) | (0.40) | (-0.76) | (-0.14) | (-1.52) | (0.26) | (-1.25) | (0.97) | (1.15) | (1.32) | (2.31) |
| | | | | | | | | | | | | |
| US | CAPM alpha | -5.27 | -1.36 | -0.78 | -0.61 | -1.38 | 1.13 | 1.16 | 1.50 | 1.72 | 1.48 | 6.75 |
| | | (-2.49) | (-0.87) | (-1.20) | (-0.25) | (-1.92) | (1.47) | (1.92) | (1.74) | (1.96) | (1.83) | (2.79) |
| | Fama-French alpha | -6.27 | -3.58 | -1.67 | -1.22 | -1.74 | 0.91 | 0.81 | 1.21 | 2.15 | 3.07 | 9.34 |
| | | (-4.10) | (-2.11) | (-2.21) | (-0.39) | (-2.21) | (0.96) | (1.83) | (1.76) | (1.99) | (2.24) | (3.87) |
| | 4-factor alpha | -5.30 | -1.67 | -1.70 | -0.84 | -1.80 | 1.28 | 0.84 | 1.60 | 1.20 | 2.56 | 7.86 |
| | | (-3.25) | (-1.42) | (-0.96) | (-0.84) | (-1.92) | (1.26) | (1.53) | (1.87) | (1.65) | (2.38) | (3.72) |

## Table 3.8

## Market Liquidity at “Good States” and “Bad States” of the Economy

The table reports the average market liquidity at “good states” and “bad states” of the economy, as well as the difference between the market liquidity in these two different states. “Good states” of the economy are characterized as the quarters that exhibit the highest 25% of future GDP growth, and “bad states” are those with the lowest 25% of future GDP growth. “Future” refers to four quarters later.

| Country | Good states (%) | Bad states (%) | Difference (%) | t-statistic |
|---|---|---|---|---|
| AUSTRALIA | -0.0584 | -0.1132 | 0.055 | 1.60 |
| AUSTRIA | -0.0009 | -0.0017 | 0.001 | 1.07 |
| BELGIUM | 0.0007 | 0.0013 | -0.001 | -1.01 |
| CANADA | -0.0550 | -0.0977 | 0.043 | 2.28 |
| DENMARK | 0.0017 | 0.0029 | -0.001 | -1.22 |
| FRANCE | -0.0041 | -0.0073 | 0.003 | 2.23 |
| GERMANY | -0.0035 | -0.0062 | 0.003 | 1.84 |
| HONG KONG | -0.0025 | -0.0045 | 0.002 | 1.81 |
| ITALY | -0.000007 | -0.00001 | 0.000006 | 0.13 |
| JAPAN | -0.000022 | -0.00004 | 0.000020 | 1.92 |
| NETHERLANDS | -0.0047 | -0.0084 | 0.004 | 0.47 |
| NEW ZEALAND | 0.0155 | 0.0251 | -0.010 | -1.31 |
| NORWAY | 0.0016 | 0.0027 | -0.001 | -1.36 |
| SINGAPORE | -0.0286 | -0.0543 | 0.026 | 0.81 |
| SPAIN | -0.0001 | -0.0002 | 0.000 | 1.58 |
| SWEDEN | -0.0026 | -0.0044 | 0.002 | 2.43 |
| SWITZERLAND | 0.0008 | 0.0015 | -0.001 | -0.30 |
| UK | -0.0017 | -0.0030 | 0.001 | 1.96 |
| US | -0.023 | -0.041 | 0.018 | 2.00 |

## Table 3.9

### Univariate Regression of Future Economic Growth on Market Liquidity

For each country, the following equation is used to estimate the sensitivity of future GDP growth to market liquidity.

$$GDPgrowth_{t+4} = a + b * MarketLiquidity_t + e_t ,$$

where $GDPgrowth$ is the year-over-year GDP growth rate four quarters later; $MarketLiquidity$ is the market liquidity at current quarter.

| Country | Slope coefficient | t-statistic | Adj. R-squared |
|---|---|---|---|
| AUSTRALIA | 21.07 | 1.79 | 0.11 |
| AUSTRIA | 0.70 | 1.41 | 0.02 |
| BELGIUM | -0.62 | -1.29 | 0.04 |
| CANADA | 23.07 | 2.48 | 0.10 |
| DENMARK | 1.16 | 0.26 | 0.08 |
| FRANCE | 1.89 | 1.53 | 0.08 |
| GERMANY | 1.30 | 1.74 | 0.11 |
| HONG KONG | 2.28 | 2.58 | 0.12 |
| ITALY | 0.002 | 1.05 | 0.03 |
| JAPAN | 0.012 | 1.26 | 0.02 |
| NETHERLANDS | -1.11 | -0.26 | 0.03 |
| NEW ZEALAND | 3.43 | 1.52 | 0.08 |
| NORWAY | -0.23 | -2.49 | 0.08 |
| SINGAPORE | 11.14 | 1.70 | 0.12 |
| SPAIN | 0.02 | 0.90 | 0.05 |
| SWEDEN | 0.94 | 3.42 | 0.08 |
| SWITZERLAND | -0.20 | -0.50 | 0.02 |
| UK | 7.65 | 1.99 | 0.12 |
| US | 16.49 | 3.93 | 0.09 |

**Table 4.1**

**World Stock Exchanges and Price Limits [a]**

| Country | Stock Exchange | Price Limit |
|---|---|---|
| Australia | Australian Stock Exchange (SE) | None |
| Austria | Wiener Borse AG | 5% |
| Bangladesh | Dhaka SE | 7.5-20% |
| Belgium | Brussels SE | 5-10% |
| Brazil | Sao Paulo | None **[b] |
| Canada | Toronto SE | None ** |
| China | *[c] | 10% |
| Croatia | Zagreb SE | None |
| Czech Republic | Prague SE | 5% |
| Denmark | Copenhagen SE | None |
| Ecuador | Guayaquil SE | 10-20% |
| Finland | Helsinki Exchange | 15% |
| France | Paris SE | 10-20%[d] |
| Germany | * | None |
| Greece | Athens SE | None |
| Hong Kong | HKSE | None |
| Indonesia | Jakarta SE | 20-50% |
| Iceland | Iceland SE | None |
| Ireland | Irish SE | None ** |
| Israel | Tel Aviv SE | 15% (during opening)** |
| Italy | Italian SE | 10-20% |
| Japan | Tokyo SE | 10-60% |
| Korea | Korea SE | 15% |
| Latvia | Riga SE | 15% |
| Lithuania | NSE of Lithuania | 5-10% |
| Luxembourg | Luxembourg SE | 5% |
| Malaysia | Kuala Lumpur SE | 30% |
| Mauritius | SE of Mauritius | 6% |
| Mexico | Mexican SE | 10% |
| Netherlands | Amsterdam SE | None |
| New Zealand | NZSE | None |
| Norway | Oslo SE | None |
| Peru | Lima SE | 15% |
| Philippines | PSE | 50% up, 40% down |
| Portugal | Lisbon and Oporto E | 15% |
| Romania | Bucharest SE | 15% |
| Singapore | Singapore SE | None |
| South Africa | Johannesburg SE | None |
| Spain | * | 10% |
| Sweden | Stockholm SE | None |
| Switzerland | Swiss Exchange | None ** |
| Taiwan | Taiwan SE | 7% |
| Thailand | Thailand SE | 30% |
| Turkey | Istanbul SE | 5% |
| United Kingdom | London SE | None ** |
| United States | * | None ** |

(a) Source: From exchange websites and correspondence with these exchanges.
(b) ** These exchanges have circuit breaker rules.
(c) * These countries have multiple exchanges where the same price limit rules apply.
(d) After merger with Amsterdam and Brussell Exchanges, these rules are under discussion.

**Table 4.2**

**Minimum Tick Size and Price Limits[a]**

| Price range | Tick size | | Maximum variation[b] | | Price limit | |
|---|---|---|---|---|---|---|
| (in yen) | yen | %[c] | yen | % | yen | % |
| 0-100 | 1 | 2.00 | 5 | 10.00 | 30 | 60.00 |
| 101-200 | 1 | 0.67 | 5 | 3.33 | 50 | 33.33 |
| 201-500 | 1 | 0.29 | 5 | 1.43 | 80 | 22.86 |
| 501-1000 | 1 | 0.29 | 10 | 1.33 | 100 | 13.33 |
| 1001-1500 | 10 | 0.80 | 20 | 1.60 | 200 | 16.00 |
| 1501-2000 | 10 | 0.57 | 30 | 1.71 | 300 | 17.14 |
| 2001-3000 | 10 | 0.40 | 40 | 1.60 | 400 | 16.00 |
| 3001-5000 | 10 | 0.25 | 50 | 1.25 | 500 | 12.50 |
| 5001-10000 | 10 | 0.13 | 100 | 1.33 | 1000 | 13.33 |
| 10001-30000 | 100 | 0.50 | 200 | 1.00 | 2000 | 10.00 |

(a) This table is reproduced from Lehmann and Modest (1994).
(b) Maximum price change that may occur between two consecutive trades.
(c) % values are a fraction of the midpoint of price range.

**Table 4.3**

**Trading Sessions Affected by Price Limits**

| | **Continuous days of hitting price limits** |
|---|---|
| positive 1 | 26 |
| positive 2 | 23 |
| positive 3 | 4 |
| positive 5 | 1 |
| positive 6 | 1 |
| subtotal of days hitting + limits | 95 |
| negative 1 | 46 |
| negative 2 | 5 |
| negative 3 | 1 |
| negative 4 | 2 |
| subtotal of days hitting - limits | 67 |
| mix 2 | 6 |
| mix 3 | 4 |
| mix 4 | 2 |
| mix 6 | 1 |
| mix 8 | 1 |
| mix 11 | 1 |
| subtotal of days of hitting + and - limits | 57 |
| total # of days hitting price limits | 219 |
| total trading sessions | 38,933 |

**Table 4.4**
**Estimation Results for the Price Differentials**

| Company | Intercept | S&P 500 | Nikkei 225 | US Volume | JP Volume | Adj $R^2$ | % Price difference |
|---|---|---|---|---|---|---|---|
| BANK OF TOKYO-MITSUB. | 0.15 | 7.11 | 0.01 | -0.000011 | 0.0000 | 0.092 | 1.00 |
| | (-12.25) | (10.96) | (-0.02) | (-3.73) | (-1.00) | | |
| CANON | -0.01 | 14.36 | 0.09 | 0.000023 | 0.0004 | 0.197 | -0.05 |
| | (-0.75) | (-20.05) | (-0.17) | (-3.13) | (-3.49) | | |
| CSK CORPORATION | 0.16 | 2.94 | -1.76 | 0.000106 | -0.0407 | -0.008 | 0.55 |
| | (-1.23) | (-0.62) | (-0.46) | (-0.79) | (-0.78) | | |
| DAIEI | 0.04 | -0.65 | 0.57 | -0.000009 | 0.0074 | -0.004 | 0.89 |
| | (-1.50) | (-0.67) | (-0.75) | (-1.03) | (-1.03) | | |
| FUJI PHOTO FILM | -0.22 | 14.34 | -0.37 | 0.000082 | 0.001 | 0.059 | -0.67 |
| | (-7.88) | (-9.67) | (-0.35) | (-3.23) | (-2.67) | | |
| HITACHI | 0.03 | 5.16 | -0.17 | -0.000004 | 0.0000 | 0.155 | 0.34 |
| | (-5.82) | (-17.47) | (-0.83) | (-3.84) | (-0.2) | | |
| HONDA MOTOR | -0.01 | 15.71 | -2.39 | -0.000012 | 0.0009 | 0.159 | -0.02 |
| | (-0.45) | (-17.76) | (-3.87) | (-1.40) | (-3.40) | | |
| ITO YOKADO | 0.10 | 11.88 | 0.21 | 0.000041 | 0.0007 | 0.018 | 0.19 |
| | (-3.05) | (-5.60) | (-0.14) | (-0.95) | (-0.61) | | |
| JAPAN AIRLINES | 0.02 | 1.16 | 0.03 | -0.000002 | 0.0001 | 0.019 | 0.49 |
| | (-4.43) | (-4.69) | (-0.18) | (-1.43) | (-1.59) | | |
| KIRIN BREWERY | 0.07 | 1.84 | -0.28 | -0.00003 | 0.0001 | 0.047 | 0.64 |
| | (-11.61) | (-5.16) | (-1.10) | (-7.13) | (-0.14) | | |
| KUBOTA | 0.06 | 0.63 | -1.25 | -0.000021 | -0.0001 | 0.135 | 1.68 |
| | (-10.82) | (-3.21) | (-8.07) | (-7.77) | (-0.04) | | |
| KYOCERA | -0.05 | 59.85 | 0.12 | -0.000017 | 0.0096 | 0.128 | -0.07 |
| | (-0.76) | (-14.97) | (-0.04) | (-0.14) | (-5.14) | | |
| MAKITA | -0.06 | 1.87 | 0.54 | 0.000163 | -0.0003 | 0.012 | -0.42 |
| | (-4.89) | (-2.97) | (-1.21) | (-2.93) | (-1.04) | | |
| MATSUSHITA ELEC. INDL. | -0.14 | 9.49 | 2.94 | -0.000801 | 0.0003 | 0.185 | -0.47 |
| | (-7.17) | (-1.21) | (-0.54) | (-9.50) | (-0.21) | | |
| MITSUI COMPANY | 0.01 | 0.65 | -0.41 | 0.000001 | -0.0002 | 0.009 | 0.16 |
| | (-1.65) | (-2.6) | (-2.07) | (-0.23) | (-0.21) | | |
| NEC | 0.01 | 7.89 | -0.48 | -0.000001 | 0.0001 | 0.188 | 0.09 |
| | (-1.56) | (-19.99) | (-1.75) | (-0.60) | (-0.22) | | |
| NISSAN MOTOR | 0.00 | 2.27 | -0.35 | -0.000005 | 0.0001 | 0.072 | 0.05 |
| | (-0.97) | (-9.41) | (-2.07) | (-6.21) | (-5.16) | | |
| NPN. TELG. TEL. | 1.64 | 14.9 | -30.74 | -0.113371 | -0.0284 | 0.097 | 0.02 |
| | (-0.98) | (-2.52) | (-1.28) | (-0.22) | (-0.66) | | |
| ORIX | 0.13 | 30.45 | -13.57 | 0.001159 | -0.295 | 0.084 | 0.11 |
| | (-0.65) | (-4.62) | (-2.34) | (-1.39) | (-4.61) | | |
| PIONEER | 0.16 | 7.78 | -4.74 | -0.000041 | 0.0059 | 0.044 | 0.76 |
| | (-7.66) | (-6.67) | (-5.66) | (-1.73) | (-2.69) | | |
| SANYO ELECTRIC | 0.01 | 0.92 | -0.54 | -0.000003 | -0.0008 | 0.041 | 0.20 |
| | (-2.46) | (-4.43) | (-3.56) | (-3.35) | (-1.73) | | |
| SAWAKO | 0.22 | -0.21 | -1.73 | -0.000481 | -0.0162 | 0.012 | 0.37 |
| | (-4.71) | (-0.19) | (-1.57) | (-1.45) | (-1.02) | | |
| SONY | 0.13 | 49.96 | -2.40 | 0.000034 | -0.0007 | 0.213 | 0.38 |
| | (-3.16) | (-20.56) | (-1.42) | (-1.98) | (-7.46) | | |
| TDK | 0.20 | 28.31 | -6.34 | -0.000299 | -0.0021 | 0.070 | 0.29 |
| | (-4.21) | (-10.88) | (-3.49) | (-2.61) | (-0.43) | | |
| TOKIO MAR. FIRE INS. | 0.03 | 3.67 | -0.22 | -0.000008 | 0.0003 | 0.094 | 0.30 |
| | (-5.96) | (-12.8) | (-1.09) | (-2.36) | (-2.72) | | |
| TOYOTA MOTOR | 0.01 | 10.57 | -2.22 | -0.000003 | 0.0000 | 0.170 | 0.05 |
| | (-1.11) | (-18.55) | (-5.55) | (-1.10) | (-0.03) | | |
| TREND MICRO | -0.65 | 267.55 | -16.65 | -0.024991 | 0.0798 | 0.308 | -0.45 |
| | (-1.31) | (-11.37) | (-0.74) | (-1.81) | (-5.13) | | |
| WACOAL | 0.05 | 0.71 | -0.32 | 0.000199 | -0.0065 | -0.004 | 0.50 |
| | (-1.55) | (-0.86) | (-0.53) | (-1.23) | (-0.76) | | |

## Table 4.5

## Estimation Results for the Price Differentials – GARCH

| Company | $a_0$ | $a_1$ | $a_2$ | Adj $R^2$ |
|---|---|---|---|---|
| BANK OF TOKYO-MITSUB. | 0.00004 | 0.14 | 0.83 | 0.17 |
| | (4.41) | (8.17) | (40.87) | |
| CANON | 0.00001 | 0.13 | 0.87 | 0.20 |
| | (3.73) | (9.03) | (58.87) | |
| CRAYFISH CO. LTD. | 0.00331 | 0.32 | 0.53 | 0.00 |
| | (2.71) | (2.71) | (4.20) | |
| CSK CORPORATION | 0.00810 | 0.22 | 0.47 | 0.11 |
| | (2.97) | (3.71) | (5.10) | |
| DAIEI | 0.00022 | 0.16 | 0.78 | 0.21 |
| | (1.82) | (5.12) | (18.83) | |
| FUJI PHOTO FILM | 0.00009 | 0.25 | 0.66 | 0.20 |
| | (5.24) | (10.27) | (19.66) | |
| HITACHI | 0.00001 | 0.06 | 0.94 | 0.20 |
| | (3.02) | (7.02) | (109.07) | |
| HONDA MOTOR | 0.00002 | 0.11 | 0.86 | 0.18 |
| | (3.62) | (7.87) | (45.69) | |
| ITO YOKADO | 0.00001 | 0.08 | 0.91 | 0.19 |
| | (3.65) | (8.51) | (92.49) | |
| JAPAN AIRLINES | 0.00018 | 0.12 | 0.78 | 0.20 |
| | (3.32) | (5.15) | (17.19) | |
| KIRIN BREWERY | 0.00021 | 0.27 | 0.52 | 0.19 |
| | (5.54) | (8.06) | (8.11) | |
| KUBOTA | 0.00048 | 0.11 | 0.64 | 0.15 |
| | (2.50) | (3.30) | (5.25) | |
| KYOCERA | 0.00000 | 0.06 | 0.94 | 0.18 |
| | (3.25) | (7.10) | (113.77) | |
| MAKITA | 0.00005 | 0.13 | 0.83 | 0.17 |
| | (4.85) | (7.34) | (40.76) | |
| MATSUSHITA ELEC. INDL. | 0.00001 | 0.06 | 0.93 | 0.16 |
| | (3.05) | (5.63) | (83.78) | |
| MITSUI COMPANY | 0.00001 | 0.11 | 0.89 | 0.22 |
| | (1.54) | (6.12) | (58.83) | |
| NEC | 0.00002 | 0.10 | 0.88 | 0.17 |
| | (3.43) | (7.20) | (51.59) | |
| NISSAN MOTOR | 0.00010 | 0.25 | 0.69 | 0.15 |
| | (5.61) | (11.10) | (25.76) | |
| NPN. TELG. TEL. | 0.00005 | 0.11 | 0.83 | 0.14 |
| | (4.11) | (7.39) | (34.14) | |
| ORIX | 0.00058 | 0.15 | 0.50 | 0.20 |
| | (3.19) | (2.58) | (3.58) | |
| PIONEER | 0.00001 | 0.03 | 0.96 | 0.14 |
| | (2.23) | (5.74) | (149.03) | |
| SANYO ELECTRIC | 0.00007 | 0.09 | 0.87 | 0.21 |
| | (3.23) | (4.06) | (29.06) | |
| SAWAKO | 0.00012 | 0.10 | 0.87 | 0.19 |
| | (1.89) | (7.21) | (15.69) | |
| SONY | 0.00000 | 0.09 | 0.91 | 0.18 |
| | (2.98) | (9.59) | (109.96) | |
| TDK | 0.00062 | 0.36 | 0.00 | 0.05 |
| | (2.18) | (1.34) | (0.09) | |
| TOKIO MAR. FIRE INS. | 0.00006 | 0.10 | 0.82 | 0.20 |
| | (3.52) | (6.21) | (25.69) | |
| TOYOTA MOTOR | 0.00002 | 0.17 | 0.82 | 0.17 |
| | (5.27) | (15.29) | (71.47) | |
| TREND MICRO | 0.00033 | 0.12 | 0.82 | 0.15 |
| | (2.12) | (2.99) | (14.23) | |
| WACOAL | 0.00089 | 0.15 | 0.60 | 0.20 |
| | (1.87) | (2.46) | (3.45) | |

## Table 4.6

### Difference in Moments (%)

| | | Hit upper limits | Hit lower limits | Hit both limits |
|---|---|---|---|---|
| Number of stocks | | 19 | 14 | 6 |
| Means | Wei-Chiang | 7.816 | -8.410 | 0.780 |
| | | (0.390) | (0.694) | (0.670) |
| | Predicted | 7.762 | -8.15 | 0.524 |
| | | (0.411) | (0.930) | (0.192) |
| | Difference in means | 0.683 | -0.789 | 0.248 |
| | | (0.422) | (0.941) | (0.361) |
| Variance | Wei-Chiang | 0.087 | 0.671 | 1.131 |
| | | (0.013) | (0.054) | (2.705) |
| | Predicted | 0.120 | 0.294 | 1.741 |
| | | (0.241) | (0.329) | (0.184) |
| | Difference in means | -0.034 | 0.378 | -0.492 |
| | | (0.023) | (0.271) | (0.680) |

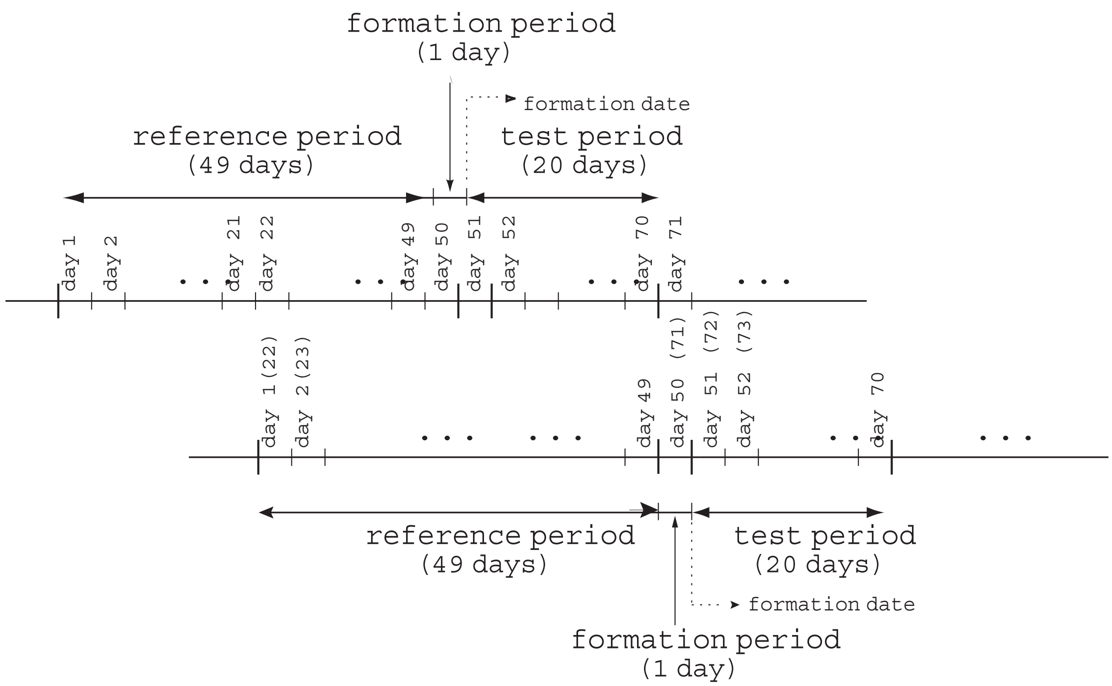
Bootstrapped standard errors are in parentheses.

# Appendix C

# Figures

## Figure 2.1. Time Sequence for the Sample

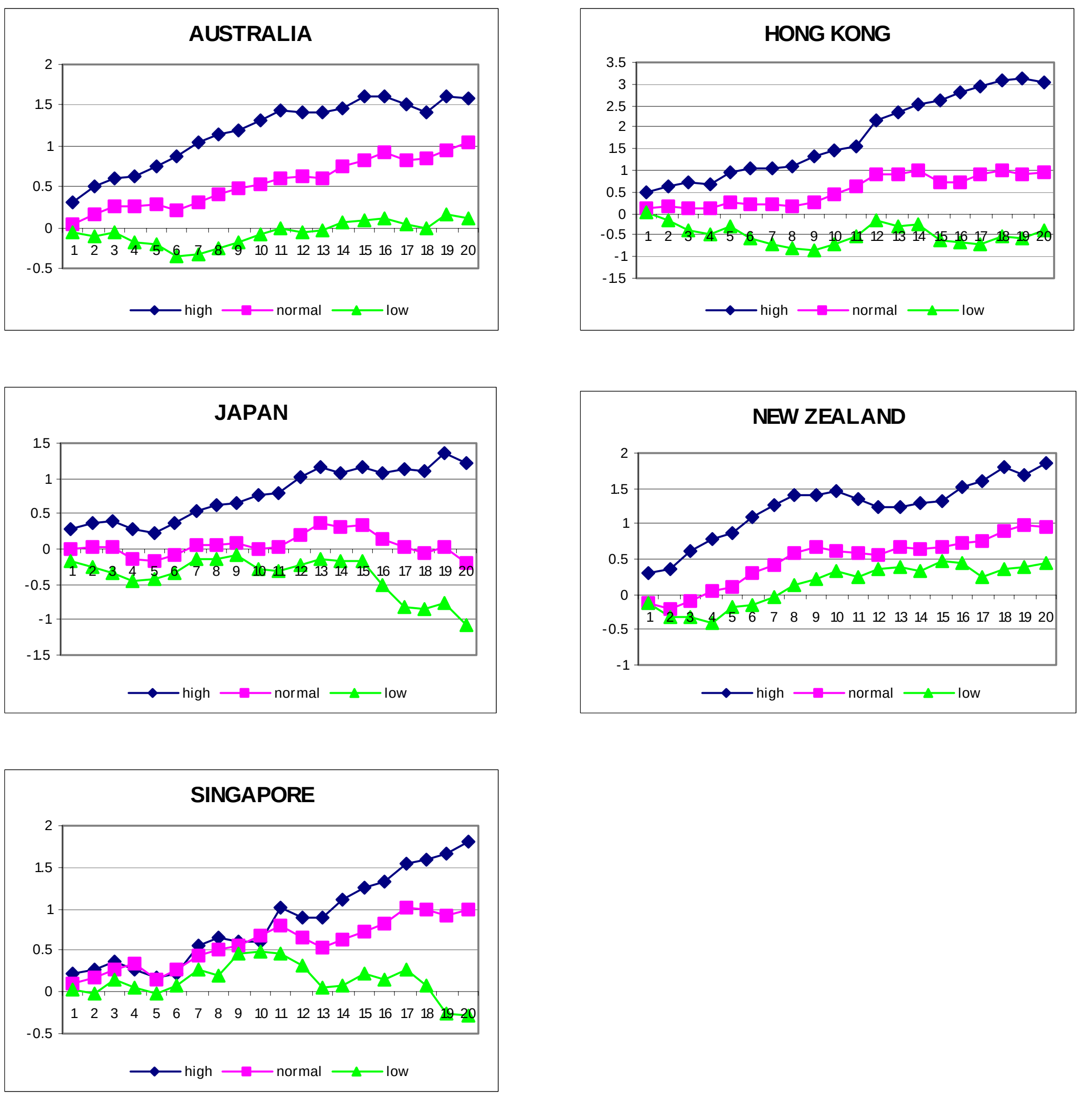
Each of the trading intervals consists of 70 trading days. In each trading interval, the first 49 days are used to measure whether trading volume during the 50th day is unusually large (top 20 percent of daily volumes during the first 50 days of the trading interval or small (bottom 20 percent). Based on this measure, portfolios are formed at the end of the 50th day, and their performance is evaluated over the subsequent 20 days.



## Figure 2.2. Evolution of the Average Cumulative Return of Stocks Conditional on their One-Day Trading Volume Shocks: Developed Markets Divided by Geographical Regions

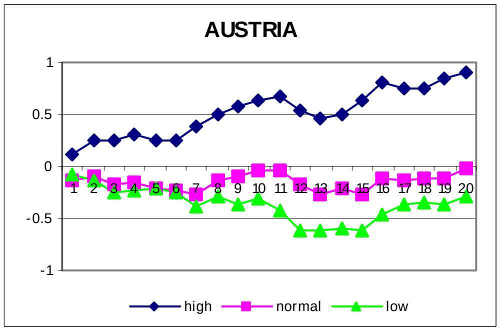
For each country, at the end of every fiftieth trading day, equally-weighted portfolios are formed according to the trading volume (as measured by the number of shares traded) experienced by each stock during that day. A stock whose trading volume that day is amongst its top (bottom) 20 percent of daily trading volumes over the previous 49 trading days is categorized as a “high volume” (“low volume”) stock; otherwise, it is categorized as a “normal volume” stock. The average cumulative return of the three portfolios is plotted in each figure.

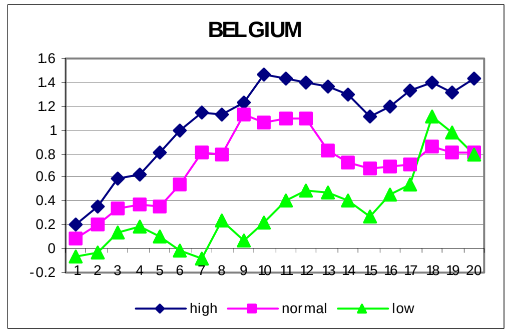
### Asia Pacific

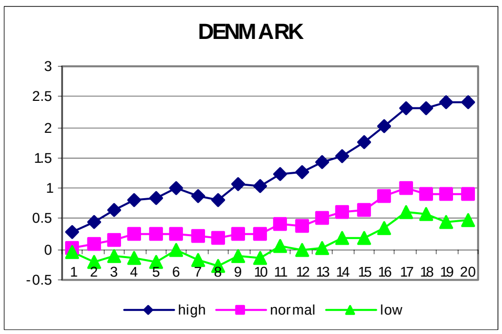


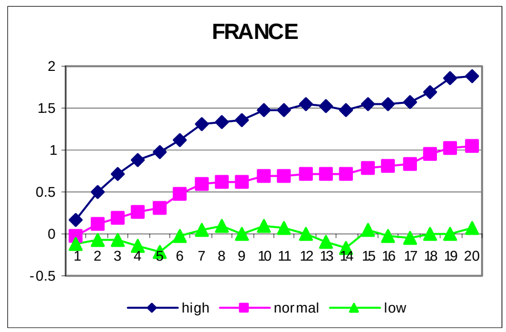
# Figure 2.2 –Continued

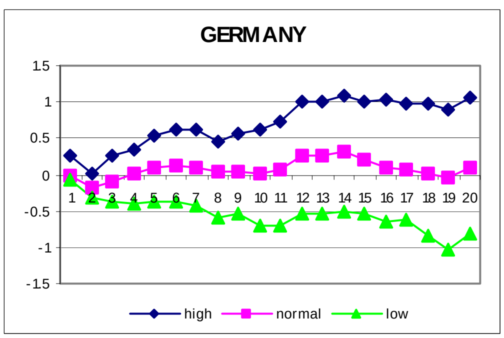
## Europe

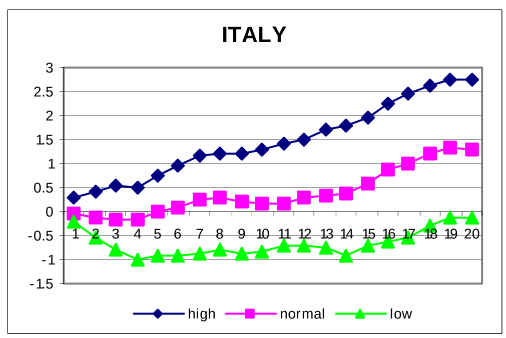


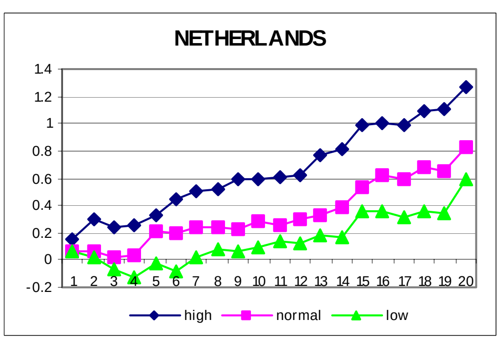



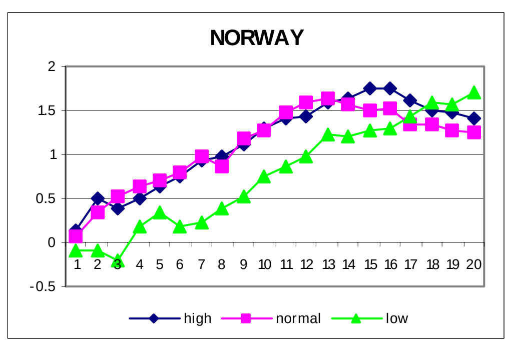
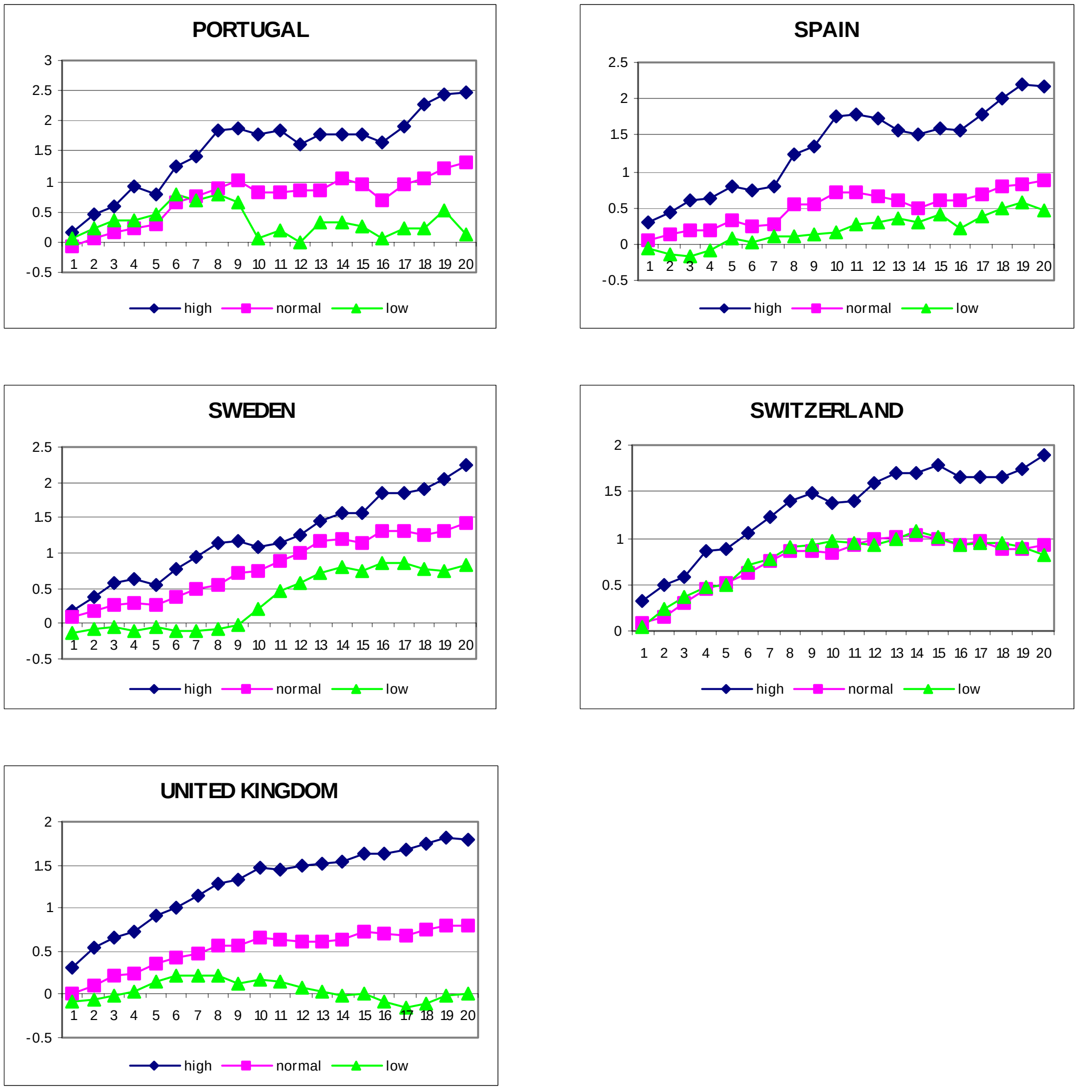
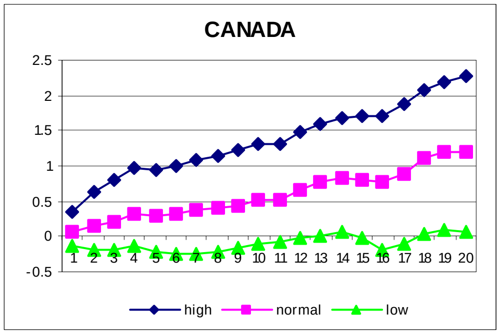



**Figure 2.2 –Continued**



## Figure 2.2 –Continued

### North America



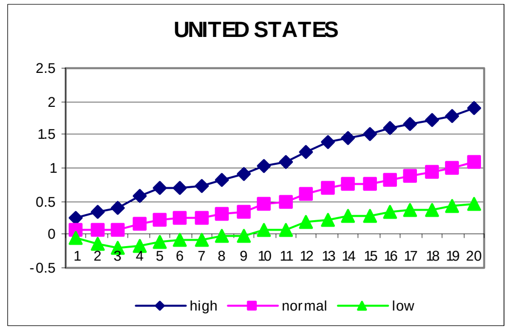
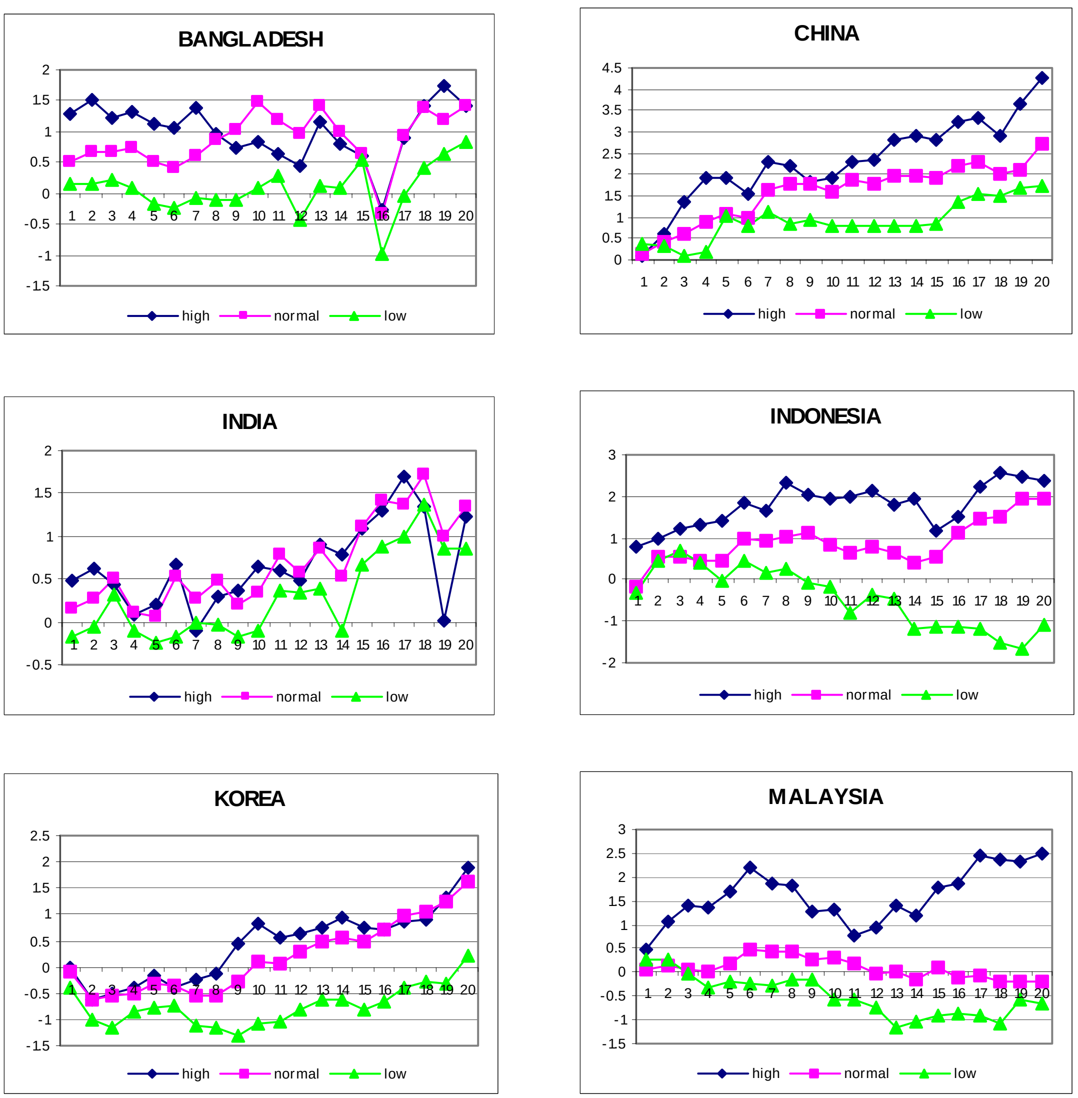



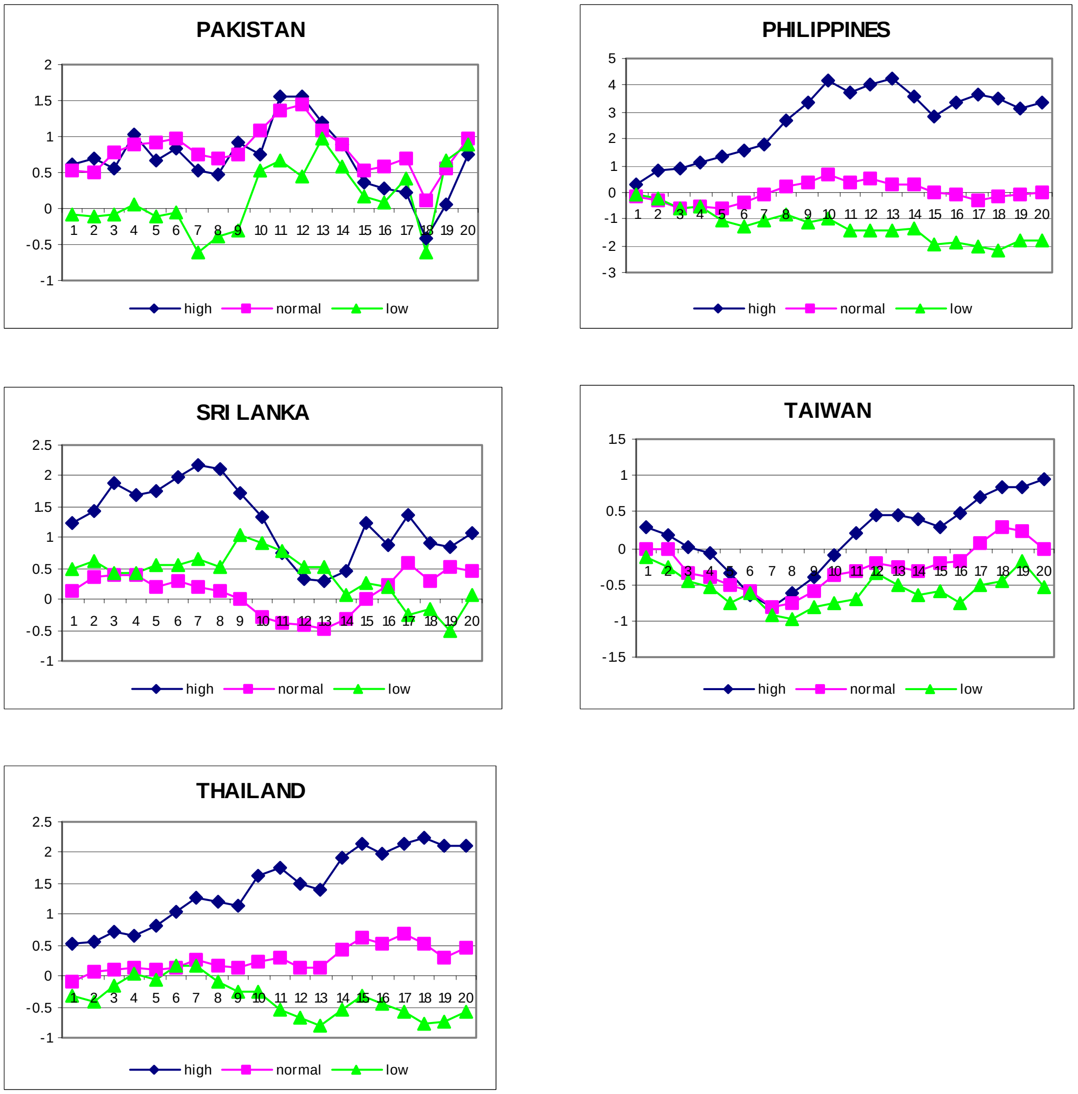
**Figure 2.3. Evolution of the average cumulative return of stocks conditional on their one-day trading volume shocks: emerging markets divided by geographical regions**

For each country, at the end of every fiftieth trading day, equally-weighted portfolios are formed according to the trading volume (as measured by the number of shares traded) experienced by each stock during that day. A stock whose trading volume that day is amongst its top (bottom) 20 percent of daily trading volumes over the previous 49 trading days is categorized as a "high volume" ("low volume") stock; otherwise, it is categorized as a "normal volume" stock. The average cumulative return of the three portfolios is plotted in each figure.

## Asia Pacific

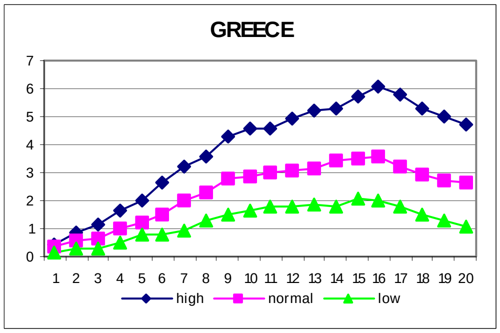


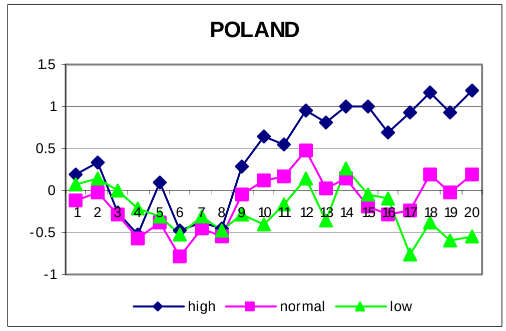
## Figure 2.3 –Continued

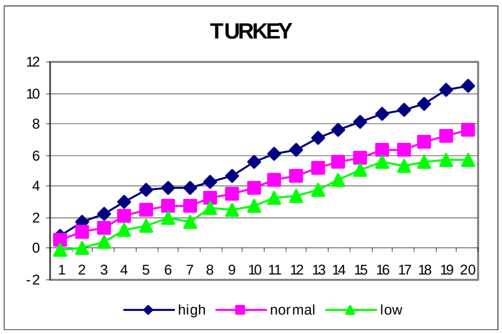


## Figure 2.3 – Continued

### Europe

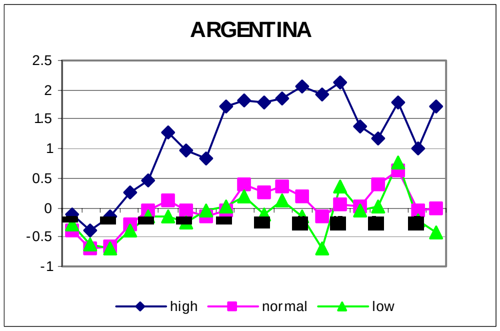


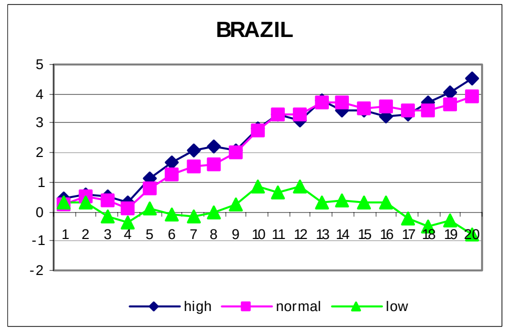



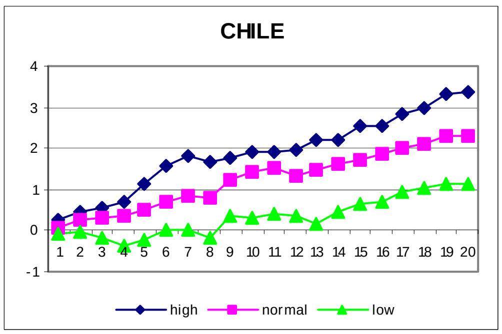



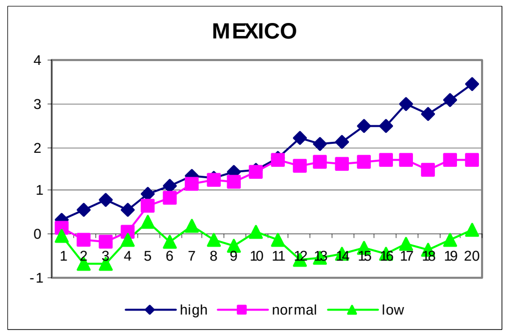
## Figure 2.3 – Continued

### Latin America

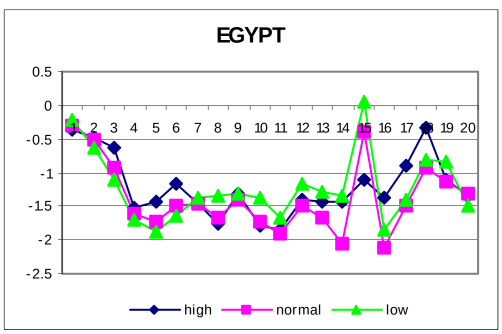


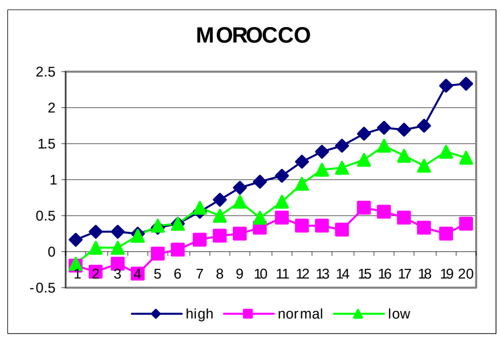




### Middle East and Africa



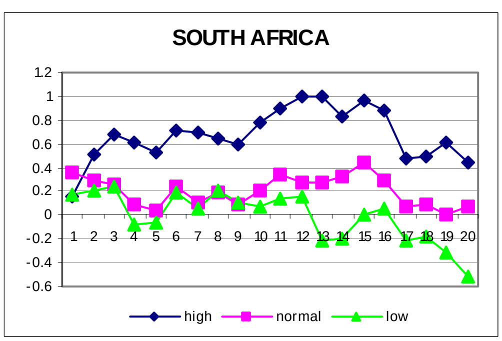



**Figure 3.1**
**Aggregate Liquidity of the U.S. Market**

For each country, each month's observation is constructed by averaging individual stocks' liquidity measures for the month and then multiplying by $(m_t / m_1)$, where $m_t$ is the total traded value in local currency at the end of month $t-1$ of the stocks included in the average in month $t$, and month $1$ corresponds to the starting month of each country. An individual stock's measure for a given month is a regression slope coefficient estimated using daily returns and volume data within that month. Tick marks correspond to July of a given year.

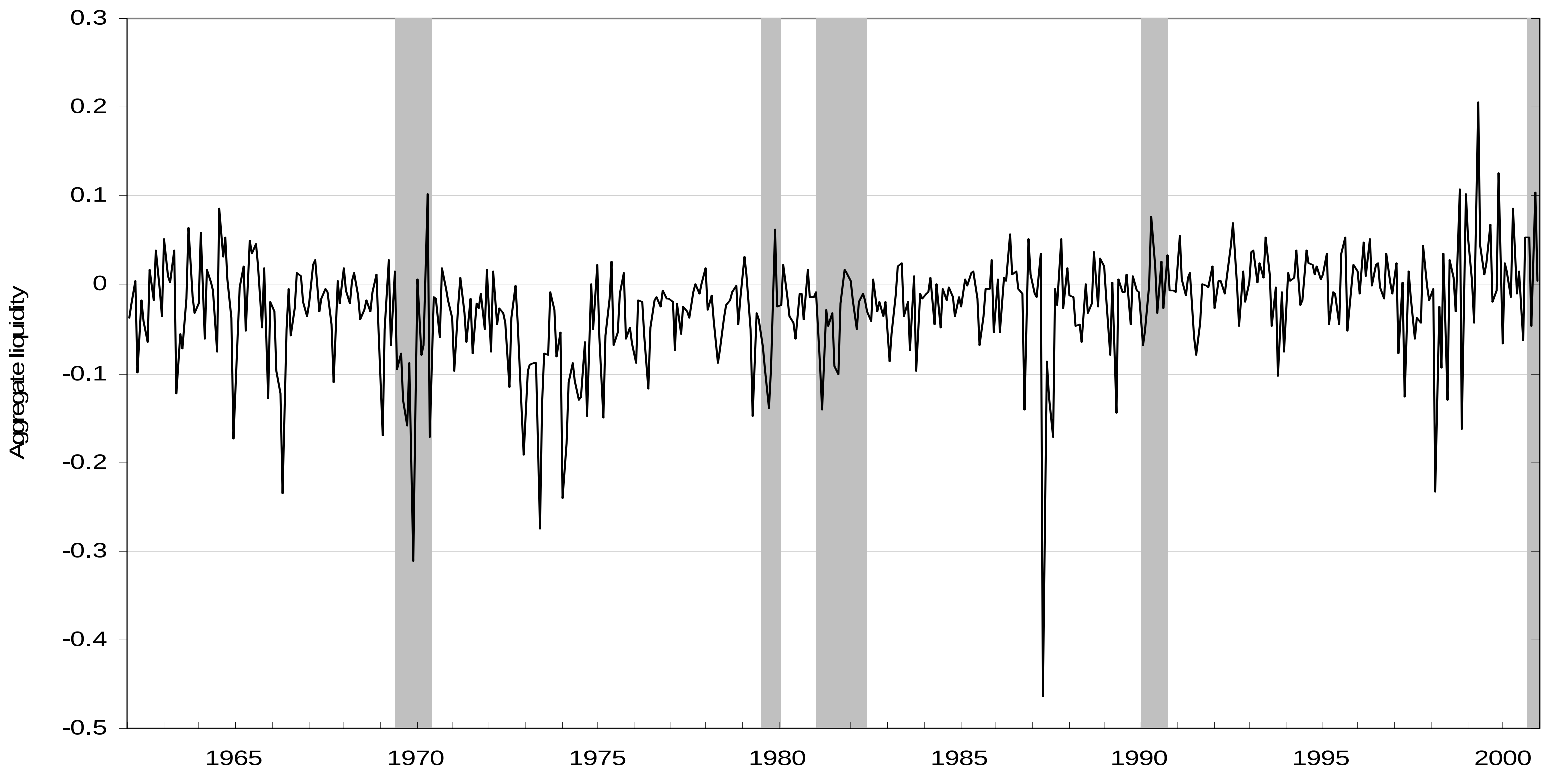
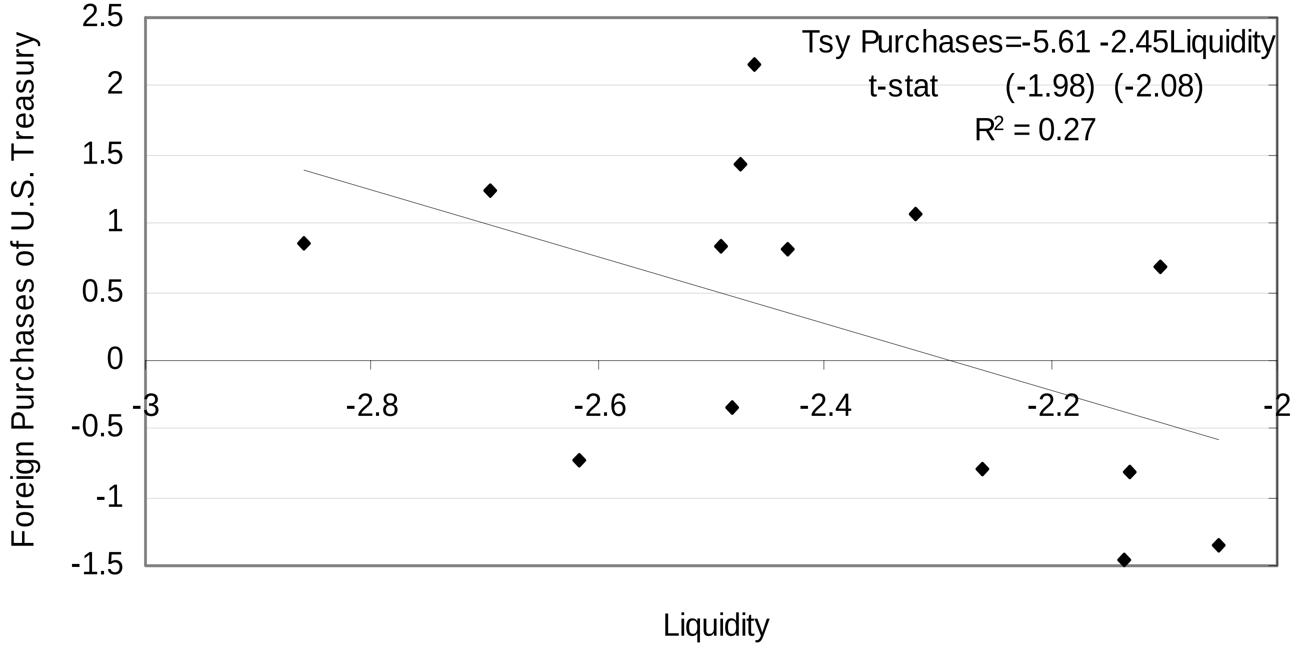


**Figure 3.2**

**Foreign Countries' Purchases of U.S. Treasuries during Months of Large Liquidity Drops**

The scatter plot represents the combinations of the market liquidity for the U.S. equity market and foreign purchases of U.S. Treasuries during months of "low liquidity". "Low-liquidity" months are those in which the market liquidity for the U.S. is at least two standard deviations away below its mean. Liquidity shown in the figure is standardized using its standard deviation and mean of each year. The same standardization is applied to foreign purchases of U.S. Treasuries. The regression line and the equation are also shown.



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