Liquidity and Asset Prices in Multiple Markets[*]

Justin S. P. Chan[†]

Dong Hong[‡]

Marti G. Subrahmanyam[§**]

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Comments welcome

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[†] Lee Kong Chian School of Business, Singapore Management University, 50 Stamford Road, Singapore 178899. Ph: (65) 6828-0718, Fax: (65) 6828-0777, E-mail: justinchan@smu.edu.sg

[‡] Lee Kong Chian School of Business, Singapore Management University, 50 Stamford Road, Singapore 178899. Ph: (65) 6828-0744, Fax: (65) 6828-0777, E-mail: donghong@smu.edu.sg.

[§] Department of Finance, Leonard N. Stern School of Business, New York University, 44, West Fourth Street #9-15, New York, NY 10012-1126. Ph: (1) (212) 998-0348, Fax: (1) (212) 995-4233, E-mail: msubrahm@stern.nyu.edu.

[**] Subrahmanyam serves on the boards of two of the companies in the sample used in this study: ICICI Bank Ltd. (NYSE: IBN) and Infosys Technologies Ltd. (NASDAQ: INFY). This study is based only on publicly available data and does not draw on any privileged information he possesses as a director of these two companies.

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Abstract

Liquidity is generally viewed as a positive characteristic of a traded asset in positive net supply. *Ceteris paribus*, the higher liquidity of a given asset should be reflected in a higher price or a lower required return. This issue is of particular interest if the *same* asset is traded in *multiple* markets. In this setting, apart from the effect of liquidity on pricing in each market, there is the additional question of transmission of these liquidity effects *across* markets. This paper investigates the liquidity effect in asset pricing by studying the liquidity-premium relationship of an American Depositary Receipt (ADR) and its underlying share in the home market. Using the Amihud (2002) measure, the turnover ratio and trading infrequency as proxies for liquidity, we show that a higher ADR premium is associated with higher ADR liquidity, lower home share liquidity. We measure these effects, in terms of both the levels and changes, in both the premium and the liquidity variables. We find that the liquidity effects remain strong even after we control for firm size and a number of country characteristics, such as the expected change in the foreign exchange rate, the home country and the US stock market performance, as well as several variables measuring the openness and transparency of the home market.

JEL Classification: G10, G12, G15

Keywords: American Depositary Receipts (ADRs), dual listing, liquidity, turnover, premium

1. Introduction

Liquidity has long been considered an important variable that affects the prices of financial assets. The vast literature on market microstructure can be regarded as a set of studies of how informational asymmetry and transaction costs affect the liquidity of assets, measured by variables such as the bid-offer spread and market depth. A particular aspect of this broad issue is how liquidity effects influence the equilibrium price of an asset. This question has been investigated extensively by several researchers including Kyle (1985), Glosten and Milgrom (1985), Amihud and Mendelson (1986), Constantinides (1986), Allen and Gale (1994), and Vayanos (1998).

At an empirical level, several studies have documented the effect of differences in liquidity on the pricing of assets. Typically, these studies analyze the effect of market frictions and segmentation on the liquidity of a pair of securities with almost identical future cash flows; these differences in liquidity, in turn, cause them to trade at vastly different prices. Examples of this phenomenon are studies by Silber (1991), for restricted stock compared with freely traded stock of the same company, Amihud and Mendelson (1991), for U.S. Treasury notes and bills of identical maturities, and Boudoukh and Whitelaw (1993), for Japanese government bonds with a similar maturity and coupon.

The liquidity effect has been examined in more detail in the context of estimating the risk-return tradeoff in capital markets. Specifically, the cross-sectional positive relation between expected returns and the *level* of liquidity has been documented in a number of studies, including Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Datar, Naik, and Radcliffe (1998). Other than the level of liquidity *per se*, Chordia, Subrahmanyam, and Anshuman (2001) find a strong cross-sectional relation between stock returns and the *variability* of liquidity. Pastor and Stambaugh (2003) find that stock returns are also related to the stocks' sensitivities to innovations in market liquidity, also known as "liquidity beta," in the cross-sectional relationship between risk and return. At the market level, Amihud (2002) shows that, over time, there is an illiquidity premium in stock returns, as the expected market illiquidity positively affects stock excess return. More recently, Acharya and Pedersen (2005) investigate the various channels for the liquidity effect on stock returns in a unified liquidity-adjusted capital asset pricing model.

In cross-sectional studies of the asset liquidity-price relationship, factor models are often used to control for common risk factors across different stocks. The question that usually arises in these types of tests is the validity of the particular asset pricing model used, and the extent to which one can empirically separate the impact of the asset-pricing model from the liquidity effects being studied. In order to isolate the specific impact of liquidity on asset prices, without contamination by other asset specific variables, it is important, therefore, to identify assets that are identical in all aspects (i.e. future cash flows, and other fundamental characteristics), except the setting in which they are traded. A natural experiment to test not only the pure liquidity effect in each market, but also the transmission of liquidity from one market to the other, is one where the *same* asset is traded in multiple markets. Other than the pure liquidity effect on asset prices in isolated markets, we use the multiple markets setting to test whether variations in liquidity *across* markets play a role in pricing an asset that is traded in multiple markets. Specifically, we test whether the price difference between two otherwise identical assets, but traded in two different markets, is partially explained by differences in liquidity between the two markets. (Other factors may include institutional differences between the markets, especially with regard to transparency, as well as the degree of segmentation/integration between the two markets.)

In this paper, we examine how the prices of two assets (yielding identical cash flow streams) differ due to differences in liquidity between the two markets. More specifically, we test the liquidity hypothesis using the price of a stock in the market for American Depositary Receipts (ADRs), in relation to that of the underlying share in the home market, after adjusting for foreign exchange rate. The ADR-home market share combination offers an ideal opportunity to test the liquidity/price relationship, since the ADR and the underlying share are claims on the *same* future stream of cash flows.

Almost all non-U.S. firms that cross-list their shares in the U.S. markets (except Canadian and some Israeli firms) do so in the form of ADRs.[1,2] Each ADR represents a specific number of underlying shares of the firm in the home market. Depositary banks,

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[1] ADRs have become important financial assets in the U.S., contributing to about 5% of the overall trading volume in the U.S. equity markets. According to the 2004 mid-year report by Citigroup Depositary Receipts Services, in May 2004, the year-to-date ADR trading value was $396.6 billion. By contrast, the May 2004 YTD trading value was $8.8 trillion for the entire U.S. stock market (excluding ADRs). In contrast to the general pattern of ADR listings, Canadian and some Israeli firms list directly on the US exchanges. Typically, Canadian stocks are directly (dually) listed on the US exchanges, due a special regulatory dispensation that has been valid for many years, and was formalized in the Canada-US Multi-jurisdictional Disclosure System, adopted by the securities regulators in the two countries in 1991 to level the playing field between the regulatory requirements in the two countries.

[2] Doidge, Karolyi and Stulz (2004) document the finding that foreign firms that issue ADRs in the U.S. are generally more highly-valued than their counterparts in their respective home countries.

such as Deutsche Bank, Bank of New York, Citigroup and JP Morgan Chase, hold the foreign shares in custody in the home market and pay all dividends and other payments to ADR holders in US dollars. Thus, ADR holders in the U.S. markets receive *exactly* the same cash flows over time (converted into US dollars) as shareholders in the home market do.[3] The price of an ADR and the price of its corresponding home share represent the value of the same underlying asset, and should, therefore, sell for the same price, in US dollars, except for the effects of time differences, market segmentation and liquidity. Therefore, studying the relation between liquidity and asset prices using ADRs has the distinct advantage of not relying on any particular asset-pricing model to control for the fundamental characteristics of the firms issuing the securities.

Amihud and Mendelson (1986) and Allen and Gale (1994) predict that high illiquidity depresses the price of an asset, due to a higher price impact induced by the trading activities among buyers and sellers. Their argument yields a particularly interesting hypothesis for securities whose *equivalents* are traded in multiple markets. In the specific context of ADRs, the higher (or lower) liquidity of the ADR, compared to its corresponding home share, should be reflected in a premium (or discount) in the price of the ADR. The reverse holds true for an ADR whose liquidity is lower than that of its home share. Indirect evidence from the existing literature supports this prediction. For instance, Alexander, Eun and Janakiraman (1988) document a reduction in a security's expected return after its international listing. Kadlec and McConnell (1994) and Foerster and Karolyi (1999) show that the reduction in expected return is associated with an increase in the share price around the listing date. They also attribute the increase in the

[3] See Foerster and Karolyi (1999) for a primer on ADRs.

share price to the superior liquidity associated with the international listing, after controlling for the *investor recognition* effect, suggested by Merton (1987).[4]

In order to explore the effects of the differential liquidities on the ADR premium, we investigate the cross-sectional relation between the ADR premium and the liquidity of the ADR and that of its underlying share, together with several other controls. We provide strong evidence for the liquidity hypothesis using a sample of 401 ADRs from 23 countries over the period between January 1981 and December 2003. We use the Amihud (2002) measure of liquidity, the turnover ratio and trading infrequency as proxies for liquidity. We primarily examine the relationship between the monthly *change* in the ADR premium and the monthly *change* in the liquidity measures. We find that the change in the ADR premium is positively correlated with the change in the ADR's liquidity, and negatively correlated with the change in the home share liquidity. The liquidity effects do not disappear even after we control for expectations about the future exchange rate change, foreign stock market return and US stock market return.

We first examine how the *change* in the ADR premium responds to a *change* in liquidity as measured by our three proxies (Amihud measures, turnover ratios, and trading infrequency). There are two important advantages of examining the *changes* in the ADR

[4] There is a vast literature on the pricing of ADRs, which is indirectly connected with the issue analyzed in this paper. Many of the papers in this literature investigate the differences in pricing between the ADR and the underlying share, and thus indirectly seek to explain the premium in relation to macroeconomic factors and the degree of segmentation/integration between the home and ADR market. See, for example, Rosenthal and Young (1990), Kato, Lin, and Schallheim (1991), Wahab, Lashgari, and Cohn (1992), Park and Tavokkol (1994), Miller and Morey (1996), Sarkar, Chakravarty, and Wu (1998), Foerster and Karolyi (1999), Dabora and Froot (1999), Grammig, Melvin, and Schlag (2001, 2005), Eun and Sabherwal (2002), De Jong, Rosenthal, and van Dijk (2004), Karolyi and Li (2003), Gagnon and Karolyi (2003), Suh (2003), Menkveld et al (2003), Blouin, Hail, and Yetman (2005).

premium and the liquidity measures (change variables hereafter). First, using change variables indirectly controls for other firm and country characteristics, which are relatively stable over time, but might affect the ADR premium cross-sectionally. For example, restrictions on foreign ownership, short sale constraints, and opaque accounting standards can hinder the arbitrage activities between the two markets. Thus, it is intuitive that these country factors can potentially determine the *level* of ADR premium cross-sectionally. However, it is not clear why these factors should affect the *change* in the ADR premium, from one month to the next, for a given pair (the ADR and its home market counterpart). On the other hand, if liquidity is truly an important factor in the pricing of the ADR and its underlying asset, we expect the change in liquidity to be related to the change in the ADR's premium. Second, the level variables are highly persistent, while the change variables are not. If we use the change variables in a panel regression, our results would be less affected by the biased standard error estimates caused by persistence in the dependent and independent variables. Hence, we believe that the regressions using change variables represent a better econometric specification to test our hypothesis.

However, as a robustness check, we nevertheless carry out regressions using the level variables with controls such as firm size. We also introduce other variables to control for the home country's openness (as measured by intensity of capital controls, the transparency and credibility of its accounting standards, the efficacy of its judicial system, corporate governance variables such as anti-director rights), as well as its market restrictions (measured by restrictions on short-sales constraints and stock ownership concentration).[5,6] These factors generally do not change much from one month to the next, so they do not appear in the regressions using change variables. However, these factors are included in the regressions using level variables since they can potentially determine the *level* of the ADR premium cross-sectionally. Indeed, we show that the liquidity effects are robust in the level regressions. Furthermore, we find a higher ADR premium is associated with higher ADR liquidity, lower home share liquidity, even after controlling for the long list of country characteristics variables.

This study improves our understanding of the importance of liquidity in determining asset prices, by examining the prices of two assets with identical cash flow claims, but traded in different markets where liquidity varies. It also contributes to the existing literature on dually listed securities. To the best of our knowledge, the study is the first to provide a comprehensive examination of the liquidity effects using both the change in, and the level of the premium and various liquidity measures.

It is interesting to relate our results to those in another setting where claims on the same set of future cash flows are traded in multiple markets: the prices of shares of closed-end funds in relation to the net asset value of the funds.[7] Recently, Jain, Xia and Wu (2004) investigate the effect of liquidity in this context by examining the relation between the

[5] Karolyi (2004) highlights the fact that the expansion of ADR programs is indeed positively associated with the foreign country's pace of international capital flows and its level of integration with the world markets.

[6] Most of these characteristics are suggested by the recent work of La Porta *et al* (1998).

[7] Several papers have investigated the premium-discount of closed-end fund shares in relation to their net asset value. Several alternative explanations, such as those based on investor sentiments, have been proposed for the size of the premium/discount. Examples include Lee, Shleifer and Thaler (1991), Chopra, Lee, Shleifer, and Thaler (1993), Chen, Kan, and Miller (1993), Bodourtha, Kim, and Lee (1995), Ross (2002), Doukas and Milonas (2004), Malkiel (1977), and Zweig (1973).

premium on closed-end country funds and market liquidity, where the fund is traded in the United States (the host market), while the underlying securities owned by the fund are traded in another country's market (the home market). They find a strong association between the fund premium and the liquidity of both the fund and the underlying securities in the host and the home markets, respectively.

The rest of the paper is organized as follows. In section 2, we discuss the ADR dataset and report summary statistics. Section 3 covers the construction of liquidity measures for the individual ADRs, the shares in the home market and the home markets as a whole. Section 4 presents our empirical findings. Section 5 concludes the paper.

2. Data

We begin the sample construction with the universe of all ADRs in the Center for Research in Securities Prices (CRSP) datasets as of December 31, 2003. Depending on the registration and reporting requirements, and trading conditions, there are four types of ADRs: Level I, Level II, Level III and Rule 144A. Only Level II and level III ADRs are listed on American Stock Exchange/New York Stock Exchange/National Association of Securities Dealers Automated Quotation System.[8] Our analysis only includes these listed (Level II and Level III) ADRs, as CRSP only covers those from AMEX, NYSE or

[8] Level I ADRs trade over the counter (OTC) on "pink sheets" and require minimal SEC disclosure and no GAAP compliance. Rule 144A ADRs are privately placed to Qualified Institutional Buyers and also do not require SEC disclosures or GAAP compliance. We exclude these from our study, due to the opacity of their price formation as well as the lack of reliable data.

NASDAQ. Based on these criteria, there are 809 ADRs in the entire CRSP dataset, of which 437 were still actively traded at the end of 2003.

Out of the 809 ADRs, we are able to match 470 with their respective home market stock prices and volumes, which are available on Datastream, and the corresponding ADR ratios (1 share of ADR = # of shares of home stock). We also exclude countries with fewer than 5 ADRs. This eliminates 30 ADRs, which represent 16 countries, and 440 ADRs remain in our database for our empirical tests.

After these initial screens, we obtain daily prices, trading volume and shares outstanding of the ADRs and U.S. daily market returns from CRSP. We then collect the same set of data for the corresponding shares in the home market from Datastream. The daily foreign exchange rates for conversion from the home market currency into U.S. dollars and the daily returns of the respective home markets are also obtained from Datastream. The sample period covers daily data for the period from January 1981 to December 2003.

One issue with our datasets is that the ADR ratios are only available at the end of our sample period. As this ratio is crucial for calculating the ADR premium, we need to make appropriate adjustments in our analysis, if the ratio changes over time. Typically, custodian banks advise firms to change the ratio to maintain a “proper” price range in the US, especially when the home share price changes significantly. In order to correct for these ratio changes, we first manually check the ADR premium pattern of each stock to identify such ratio changes. Out of the 440 ADRs we checked, 275 do not appear to have such a ratio change during the period under investigation. The ratios of 126 ADRs apparently changed and the old ratios are easily identifiable (e.g. the ratio changed from 1:5 to 1:1). We manually correct the old ADR ratios for these ADRs in our database on these dates. We are unable to explain the premium pattern for the other 39 ADRs, which might be due to data errors or mismatching of data from CRSP and Datastream in the first step of our sample construction. We, therefore, eliminate these 39 ADRs from our sample.

In our final sample, there are 401 ADRs from 23 countries from January 1981 to December 2003. During this period, with the increasing trend towards globalization of financial markets, the ADR, as a financial instrument, has been growing in popularity. As a result, there are more ADRs towards the end of our sample period, particularly in the last 5 years. On average, there are 183 ADRs that were traded each month during our whole sample period.

Table 1 reports the summary statistics of the final sample. Not surprisingly, there are more ADRs of firms from the developed markets, since these markets had fewer trading restrictions, particularly in the earlier years, compared to the emerging markets. In our sample, therefore, the UK has the most firms, with 92 ADRs traded in the U.S. Other countries with more than 20 ADRs include France (29), Germany (24), Japan (32), Hong Kong (23), and Australia (24). In recent years, there is an increasing tendency for companies from emerging economies, especially from Asia and Latin America, to raise capital in the form of ADRs. Hence, there are also significant numbers of ADRs included in our sample from emerging market countries, such as Korea (9), India (10), Taiwan (10), Mexico (18), Chile (17), Brazil (12), Argentina (10) and South Africa (14).

Columns 4 and 5 report the statistics on market capitalization (MV) of the ADRs in our sample. The MV is calculated using data on the home share price and the exchange rate from Datastream, as the data for shares outstanding on CRSP refer only to those in ADR form and not the total number of shares. The numbers reported are the time series averages of the monthly median (mean) market capitalization of the ADRs for each country. According to the average of monthly median, companies from Spain have the highest MV (US$38.6 billion), while those from Israel have the lowest (US$396.75 million). For all companies from all countries, the average of the monthly MV medians is US$3.17 billion and the average of the monthly MV means is US$8.51 billion.

The statistics on the ADR premium are reported in column 6 and 7. We first compute the daily ADR premium as defined below:

$$Prem_{i,d} = \frac{P_{i,d}^{adr} * ER_d}{P_{i,d}^{hs} * AR_{i,d}} - 1 \qquad (1)$$

where $Prem_{i,d}$ is the premium (discount) for ADR *i*, if it is positive (negative) on day *d*, $P_{i,d}^{adr}$ is the ADR price from CRSP, $P_{i,d}^{hs}$ is the home share price from Datastream, ER_d is the currency exchange rate, and $AR_{i,d}$ is the ADR ratio, i.e. the number of home shares equivalent to 1 share of ADR. After we compute the daily premium for each ADR, we compute the average for each month to get its monthly premium. Since we construct the ADR's monthly premium by averaging its daily premium within each month, and our regressions are all based on monthly observations, we believe that the time differences between two markets and the possible time-zone effects will have little impact on our empirical analysis[9]. We again report the time series average of the monthly median (mean) premium of the ADRs for each country. According to the average of the monthly medians, the country ADR premium ranges from -10.54% (Netherlands) to 21.53% (India). The average premium for all ADRs from all countries, however, is close to zero (0.01%). If the average of the monthly means is used, there is a small premium for all ADRs (1.13%). Compared with the average closed-end fund discount of 4.47%,[10] this statistic is consistent with our conjecture that the arbitrage forces are stronger in eliminating the ADR premium as the underlying asset is perfectly identifiable, and hence, the price is observable. Thus, we are potentially likely to have a "cleaner analysis" of the ADR liquidity-price relationship, compared with other asset classes.

3. Liquidity Measures

3.1 The Amihud measure, the turnover ratio, and trading infrequency

In simple terms, illiquidity can be thought of as the sensitivity of asset returns (or prices) to order flow. The larger the illiquidity, the greater is the impact of a particular level of

[9] To check this conjecture, we test the sensitivity of results by computing the daily premium differently: by comparing the U.S. price on day d-1 and the home market price on day d, or alternatively, by comparing the U.S. price on day d+1 and the home market price on day d. The empirical results are essentially the same as those when the premium is computed as in equation (1).
[10] Jain, Xia and Wu (2004).

order flow on the asset price. Unfortunately, illiquidity is not an observable variable and is somewhat difficult to quantify, sometimes even with actual market microstructure data. In practice, several illiquidity proxies are used and their impact on stock returns has been well documented in the existing academic literature. The most traditional measure of illiquidity is the quoted bid-ask spread employed in Amihud and Mendelson (1986). Chalmers and Kadlec (1998) use the effective spread obtained from quotes as well as from subsequent transactions. Brennan and Subrahmanyam (1996) measure illiquidity based on the price response to signed order flow (i.e. using opposite signs for buy and sell orders) using intra-day data on transactions and quotes. Easley, Hvidkjaer and O'Hara (2002) introduce a measure of the probability of information-based trading (PIN), which captures the information asymmetry aspect of illiquidity, i.e., the likelihood that the next trade comes from an informed agent. They show that PIN has a direct impact on expected stock returns, independent of the stocks' illiquidity and return characteristics.

This paper examines the relationship between liquidity and stock prices using ADR data. As discussed above, the primary advantage of using ADR data is that we potentially have a relatively "clean" analysis of the liquidity-price relationship, since ADRs and their home market counterparts are claims with identical future cash flows. Unfortunately, a drawback of analyzing ADRs in relation to their home market counterparts is that it is difficult to apply these microstructure-based measures with the available data. Although intra-day data on transactions and quotes are available for the ADR market in the U.S. (e.g. the Trades and Quotes (TAQ) database of the New York Stock Exchange), these are often not available for individual foreign stock markets. As a result, we are constrained to obtain alternative liquidity measures that use only daily return and volume data as inputs. Indeed, these measures were developed, in part because data availability is sometimes an issue even with regard to microstructure studies in the U.S. markets.

Among the first measures using only daily return and price data is the “Amivest” liquidity ratio, which is defined as the average of daily ratio of volume to absolute return. This measure has been used in the studies of Cooper, Groth and Avera (1985), and Amihud, Mendelson, and Lauterbach (1997), among others. Another measure closely related to the Amivest ratio is the Amihud (2002) illiquidity measure, which is based on Kyle’s (1985) *lambda* and calculated as the average of daily ratio of absolute return to volume (the reciprocal of the Amivest liquidity ratio). This measure is intuitively appealing in the sense that it measures the daily price impact of the order flow, which is exactly the concept of illiquidity, since it quantifies the price/return response to a given size of trade. Finally, Pastor and Stambaugh’s (2003) liquidity beta estimates the liquidity cost from signed volume-related return reversals using daily return and volume data.

Clearly, any candidate metric for liquidity, using only daily price and volume data, needs to be positively correlated to the finer measures using microstructure data. This would justify its use, especially when the latter high frequency data are unavailable. Hasbrouck (2005) addresses this issue by evaluating the various alternative liquidity measures using daily data and estimates their correlations with the microstructure-based measures. He finds that the correlations between the Amihud (2002) measure and various microstructure-based measures are higher compared with those involving the Amivest measure. He also finds that the Pastor and Stambaugh (2003) measure is weakly correlated to microstructure-based measures, and sometimes with the wrong sign and should be used with caution.

In our analysis, we use the Amihud (2002) measure of liquidity, which is founded on the basic intuition about a security's price impact (i.e. Kyle's λ), and can be easily computed from the foreign and U.S. market daily price and volume data. Besides, its robustness has been tested in relation to other microstructure-based measures of liquidity, as documented by Hasbrouck (2005), for example.[11] Intuitively, liquidity includes two dimensions: the *liquidity level* and the *liquidity risk*. The level of liquidity is the predictable part of the tradability of the security without suffering the adverse consequences of market impact. Liquidity risk, on the other hand, arises from the unpredictable changes in liquidity over time. In this paper, we focus on the effect of liquidity level, since we need to first establish whether this matters for the pricing of ADRs, before examining the effect of liquidity risk. Also, the existing literature appears to indicate the *liquidity level* is of more importance in determining an asset's price.[12] Thus, our procedure begins with calculating the liquidity measure for each ADR and its home market counterpart. We first obtain the daily measure, when it is well defined.[13] We then average it across all

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[11] Hasbrouck (2005) points out that the sample distribution of the Amihud measure exhibits remarkably high skewness and kurtosis, and suggests the use of the square root of this measure to reduce the impact of the extreme values.

[12] Acharya and Pedersen (2005) estimate that, in the US markets, the return premium due to liquidity level is 3.5%, while the return premium due to commonality in liquidity with market liquidity, cov($Liquidity_i$,$Liquidity_M$) is only 0.08%. They also estimate the premium due to the other cross liquidity-market risk factors, cov($Return_i$, $Liquidity_M$) and cov($Liquidity_i$, $Return_M$) to be 0.16% and 0.82%, respectively.

[13] The measure is not defined if there is no trading on a particular trading day.

trading days of a specific month to obtain the monthly measure. Since the Amihud (2002) measure is defined to be the ratio of absolute return to the *dollar* trading volume, our monthly Amihud measure $Liq_{i,c,t}^{adr}$ for ADR *i* of country *c*, in month *t* is defined as:

$$Liq_{i,c,t}^{adr} = \frac{1}{D_t}\sum_{d=1}^{D_t}\frac{\left|R_{i,d}^{adr}\right|}{Vol_{i,d}^{adr}} \tag{2}$$

where D_t is the number of trading days in month *t*, $R_{i,d}^{adr}$ is the daily return of ADR *i* on day *d* (within month *t*), and $Vol_{i,d}^{adr}$ is the dollar trading volume of ADR *i* on day *d*, defined as number of shares traded times the ADR price on day *d*.

The monthly Amihud measure for the ADR's home market counterpart, $Liq_{i,c,t}^{hs}$, is defined similarly, except that the daily money trading volume in that market is converted into U.S. dollars at the corresponding spot exchange rate on day *d*. The purpose of this adjustment is to ensure that the measure is calculated on the same basis for all stocks from different countries.

In our cross-sectional analysis, we employ both the Amihud measure of the ADR, $Liq_{i,c,t}^{adr}$, and of its home market counterpart, $Liq_{i,c,t}^{hs}$. Since the daily return of the ADR, $R_{i,d}^{adr}$, and that of its corresponding home share, $R_{i,d}^{hs}$, are approximately equal on any given day, the difference between $Liq_{i,c,t}^{adr}$ and $Liq_{i,c,t}^{hs}$ is largely determined by the respective dollar trading volumes in the U.S. and in the home market. This might create a measurement discrepancy between these two variables, since the numbers of floating shares are very different in the two markets. To address this issue, we use turnover ratio as an alternative liquidity measure and carry out the same analysis. The turnover ratio measures how actively the stock is being traded, adjusted by the number of shares outstanding, and thus, available for trading. Chordia, Roll, and Subrahmanyam (2000) also document high correlations between the quoted bid-ask spread and various volume measures, which include share volume, dollar trading volume, and turnover. The monthly turnover ratio $TO_{i,c,t}$ is simply defined as the average of daily turnover ratios in each month:

$$TO_{i,c,t}^{adr} = \frac{1}{D_t}\sum_{d=1}^{D_t}\frac{Vol_{i,d}^{adr}}{SO_{i,d}^{adr}}\,; \qquad TO_{i,c,t}^{hs} = \frac{1}{D_t}\sum_{d=1}^{D_t}\frac{Vol_{i,d}^{hs}}{SO_{i,d}^{hs}} \tag{4}$$

where $Vol_{i,d}^{adr}$ is the number of ADR shares traded and $SO_{i,d}^{adr}$ is the total ADR shares outstanding on day *d* in the U.S. market. $Vol_{i,d}^{hs}$ and $SO_{i,d}^{hs}$ correspond to the number of home shares traded and total shares outstanding in the home market, respectively.

In extreme cases, some ADRs are so illiquid that there is virtually no trading at all during many regular trading days in the U.S. markets. We believe that this type of trading infrequency captures another aspect of illiquidity. So we construct another variable, the monthly trading "infrequency," defined as number of days that the ADR is *not* traded divided by the total number of trading days in the month. This trading infrequency is typically a consideration only with the ADR shares, but not their home market counterparts, since the underlying shares in the home markets are generally those of the larger companies, and hence more actively traded in those markets. Hence, in virtually all cases, we observe that the home shares are traded on almost every trading day.

3.2 Summary statistics and correlations between the alternative liquidity measures and size

Panel A in table 2 provides a brief overview of the statistical characteristics of the Amihud measure and the turnover ratios of ADRs and the underlying securities in their home markets. Notably, all variables, except trading infrequency, span wide ranges, cross-sectionally in our dataset. Take the home share Amihud measure as an example: the time series average of the monthly cross-sectional mean is 0.0332, while it has a (cross-sectional) standard deviation of 0.1730. It is interesting to note that a significant number of ADRs are not traded every day, since the average of the cross-sectional mean trading infrequency is 0.1147, which means that, on average, the typical ADR has zero trading volume in about 2 trading days per month. Investors who hold (or plan to buy) ADRs that have a lower frequency of trading certainly face some liquidity risk if they were to sell (or add to) their holdings.

Panel B in table 2 provides the correlation coefficients among the liquidity measures, the size of the ADR and its home counterpart. The size of the ADR and the size of the home market counterpart are typically quite different, since we only calculate them by multiplying the price and the outstanding shares in the U.S. market and the home market, respectively. (A typical firm in our sample has 5%-10% of its total outstanding shares traded in the U.S. in ADR form.) There are two sets of correlations between the variables – in the home markets and in the U.S. market, respectively. However, a striking similarity is observed in the correlation pattern between the two sets. Surprisingly, the Amihud measure has low correlation with the turnover ratio in both markets. This may suggest that the two measures capture different aspects of the stock's illiquidity that are somewhat orthogonal to each other. Since the Amihud measure is negatively correlated with firm size, a given amount of trading volume could lead to a large price movement for a smaller firm, and hence, a greater Amihud measure. The turnover ratio is also negatively correlated with size, which might be consistent with the fact that smaller stocks tend to be held by retail investors, and thus have a higher turnover ratio. Interestingly, the trading infrequency is positively correlated with the Amihud measure. This is consistent with our intuition that if a stock trades less often, it is likely to lead to large price movement *once* it is traded. Finally, trading infrequency has a negative correlation with size, as expected.

4. Methodology and Empirical Results

4.1. The Model

As discussed in the introduction, holders of ADRs and the underlying shares in the home market have identical claims to the firm's future cash flows. However, this does not guarantee that the ADR and its underlying share trade at the same price, when there is a certain level of market segmentation between the two markets, even apart from differences between the time zones of the two markets. Our focus in this paper is to study whether the differences in liquidity in the two markets have effects on the price of the ADR in relation to the home share, apart from these other effects. If liquidity is an important factor in pricing the asset, different levels of liquidity in the host (ADR) market and home market can potentially cause the ADR price to deviate from the price of its underlying asset, thus creating a premium (or a discount). High liquidity in the ADR market increases the price of the ADR and its premium. On the other hand, high illiquidity in the home market depresses the price of the home share, thus increases the ADR's premium. Therefore, we expect a positive relationship between the premium and the ADR's liquidity, and a negative relationship between the premium and the liquidity of the underlying share in the home market.

In addition to the liquidity differences, investors in the two markets face many institutional and informational differences. In a prior study, Gagnon and Karolyi (2003) use daily data to document that the ADR premium has a higher systematic co-movement with the U.S. market index and a lower systematic co-movement with the corresponding home market index. They also show that the "excessive co movements" are influenced by factors that impede arbitrage activities. The factors they study include three major categories: first, market-based ones such as investment barriers, short-sales restrictions, accounting standards, legal protection, etc., which are regulatory in nature; second, information-based factors such as the degree of synchronization of the common movement between the stock and the home market, the existence of asymmetry of information between insiders and other shareholders; and third, trading-based factors such as whether the cross-listed stocks have a “preferred” trading location, which we believe is indirectly related to our concepts of liquidity. Since all these country factors affect arbitrage activities between the home and ADR markets, they could potentially explain the variations in the ADR premium.

In our model, we conjecture that the cross-sectional differences of the ADR premium are determined both by the liquidity effects and the country factors. The relationship can be described in the following equation:

$$Prem_{i,t} = X_{i,t} * b_x + Z_{i,t} * b_z + \varepsilon_{i,t} \qquad (5)$$

where $Prem_{i,t}$ is ADR i’s premium in month t, defined as the average of the daily premium in equation (1). $X_{i,t}$ is a vector of the liquidity measures discussed in section 3, and $Z_{i,t}$ is a vector of country factors discussed above. To estimate (5) with panel data, one should note that there is an important difference in the properties of $X_{i,t}$ and $Z_{i,t}$: The vector $X_{i,t}$ measures the liquidity of the ADR and its home counterpart, and varies from one month to the next, while the vector $Z_{i,t}$ measures country characteristics, which usually do not change much from month *t-1* to month *t*. Since the liquidity effects are the focus of this study and we are interested primarily in the coefficients b_x, we instead estimate the model in first differences:

$$\Delta Prem_{i,t} = \Delta X_{i,t} * b_x + \Delta\varepsilon_{i,t} \qquad (5’)$$

which is the difference of equation (5) in *t-1* and *t.* Note that $Z_{i,t}$ and b_z drop out because $Z_{i,t}$ does not change from *t-1* to *t*. Intuitively, the country factors can potentially determine the *level* of ADR premium cross-sectionally.[14] However, as mentioned above, it is unlikely that there is such a relationship between the *changes* in these factors and the *change* in the ADR premium. On the other hand, our liquidity measures vary substantially from month to month. If liquidity is truly an important factor in the pricing of the ADR and its underlying asset, we expect the *change* in liquidity to be related to the *change* in the ADR's premium. Estimating equation (5') allows us to obtain unbiased estimates of the liquidity effects, without the complication of the time-invariant components $Z_{i,t}$ in equation (5)[15].

Another advantage of using equation (5') is due to another potential important statistical property of the liquidity measures $X_{i,t}$ and the ADR premium $Prem_{i,t}$. Although $X_{i,t}$ and $Prem_{i,t}$ do vary from month to month, these variables are highly persistent in nature. The average first-order auto-correlation of $Prem_{i,t}$ is about 45%, and those of the $X_{i,t}$ falls in the range of 40%-65%. With such a high degree of persistence in the dependent and independent variables, in terms of levels, we are likely to obtain biased standard errors of the coefficient estimates. On the other hand, although there is still some degree of persistence in the change variables, $\Delta X_{i,t}$ and $\Delta Prem_{i,t}$, the average first-order auto-

[14] In addition, $Z_{i,t}$ may also include firm characteristics that do not change much from month to month, such as firm size, value/growth characteristics, or analyst following, although their effects on the ADR premium are unclear intuitively.

[15] As a robustness test, we estimate equation (5) and report the results in a later subsection.

correlation coefficients are much lower, and fall in the range of -10% to -25%. With proper econometric controls, this problem is less severe in nature, in the context of obtaining unbiased estimates of the coefficients from our regressions.

Given the advantages of using the change variables discussed above, we estimate equation (5') with panel data. The estimates for b_x are the OLS estimates, and the corresponding t-statistics are calculated, using Rogers standard errors, clustered by firm, as suggested by Petersen (2005).

4.2. Liquidity Effects

By expanding equation (5'), we have the following equation:

$$\begin{aligned}\Delta Prem_{i,t} &= b_{0,t} + b_1 * \Delta Liq^{adr}_{i,c,t} + b_2 * \Delta Liq^{hs}_{i,c,t} \\ &+ b_3 * \Delta TO^{adr}_{i,c,t} + b_4 * \Delta TO^{hs}_{i,c,t} + b_5 * \Delta Infreq_{i,c,t} + \varepsilon_{i,c,t}\end{aligned} \tag{6}$$

In the above regression, the right hand side includes the various liquidity measures we discussed in section 3. $\Delta Liq^{adr}_{i,c,t}$ and $\Delta Liq^{hs}_{i,c,t}$ represent the *change* in the ADR and home share Amihud liquidity measures, respectively. $\Delta TO^{adr}_{i,c,t}$ and $\Delta TO^{hs}_{i,c,t}$ denote the *change* in the ADR and home share turnover ratios, respectively. $\Delta Infreq_{i,c,t}$ is the *change* in the monthly trading infrequency of the ADR. Our intuition suggests that the estimates of regression (6) should be $b_2>0$, $b_3>0$, and $b_1<0$, $b_4<0$, $b_5<0$.

Table 3 summarizes the main results. We estimated (6) using different sets of independent variables, which allow us to gauge the relative impact on the change in the ADR premium of the change in the ADR illiquidity, home share illiquidity. Regression I estimates the relation between ADR premium and the illiquidity of the underlying assets, when the Amihud measures are used. Regressions II and III estimates the same relationship when turnover ratios and trading infrequency are used, respectively. In regression IV, we include the Amihud measures, the turnover ratios, and trading infrequency to see if the estimates differ significantly from the previous setups.

The results in table 3 are both intuitive and consistent with our expectations regarding how illiquidities in the home and host markets are related to the ADR premium. Regression I shows that the change in the ADR premium is negatively related to the change in its Amihud measure, suggesting that the increase of the ADR's illiquidity in the U.S. market has an impact on reducing the ADR premium (i.e., reducing the ADR price in relation to its home market counterpart). On the other hand, the change in the ADR premium is positively, although weakly related to the change in the Amihud measure of its home country counterpart, indicating that an increase in the home share illiquidity might depress the home share's price and increase the ADR's premium in the U.S. market, as the ADR investors in the U.S. are not subject to the illiquidity in the home market.[16]

[16] Following the suggestion of Hasbrouck (2005), we also use the square root of the Amihud measures in our regressions as a robustness check. The results are qualitatively the same with those when the simple Amihud measure is used; therefore, we do not report those results in this paper.

The results in regression II and III are also consistent with our main hypothesis, but the significance is somewhat marginal. Higher ADR turnover corresponds to higher liquidity, and thus a higher ADR premium. In contrast, higher home share turnover corresponds to a lower ADR premium. As expected, the signs of b_1, b_2 (in regression I and II) are opposite to the signs of b_3, b_4, since the Amihud measure could be thought of as a *scaled* reciprocal of the volume measures. In regression III, the inverse relationship between the ADR premium and the trading infrequency is anticipated, since the latter is *partially* related to illiquidity. We expect infrequently traded securities to be a subset of illiquid assets, although the two dimensions are likely to offer different perspectives regarding the liquidity and informational content of an asset.

Regression IV illustrates the full regression result of equation (6), with the Amihud measures, the turnover ratios and the trading infrequency being used as explanatory variables. The result shows that the changes in all measures explain the premium, with the correct signs as in regression I – III. Even though all three illiquidity measures contain illiquidity information, using all of them in the same regression does not appear to diminish their respective individual explanatory powers. This can be clearly seen from the similar levels of significance of the estimates b_1, b_2, b_3, b_4, and b_5 in regressions I - IV, respectively.

4.3. Expectations about the future exchange rate and stock market movement

Since ADR investors are, in essence, U.S. (or more generally, global) investors interested in taking a position in foreign stock markets, their expectations regarding future exchange rate movements and future foreign stock market performance are potentially important factors in ADR pricing.

If an investor owns an ADR of a firm from country A, she would get an additional benefit if A's currency appreciates against the U.S. dollar, everything else being equal. Thus, she would be willing to pay a higher premium if she expects A's currency to appreciate in the future. (This argument presumes some transaction costs or frictions that make it costly or difficult for the investor to speculate directly on A's exchange rate, since the ADR is an indirect and somewhat risky bet on the exchange rate.) We use the most recent 1-month or 6-month exchange rate change as a proxy for such expectations. Since our exchange rate is defined as the number of units of the foreign currency per U.S. dollar, a positive exchange rate change indicates a depreciation of foreign currency, while a negative change indicates appreciation. Based on this intuition, we should expect its coefficient to be negative. Similarly, if the investor expects the stock market of country A to perform better in the future than the U.S.market, she might be willing to pay a higher premium for an ADR from country A. (Again, this presumes that other ways of placing this bet are costly or have significant constraints attached to them.) We also use the most recent 1-month (or 6-month) stock market performance as a proxy for such expectations, and include it in the regressions[17]. We expect the estimated coefficient to be positive for

[17] A possible proxy for expectations about the future would be the respective forward rates/prices. However, given the relative stationarity of the interest rates, this would effectively be a scaled version of the spot rate/price. A better alternative would be to assume that investors form their expectations about changes in the future performance of the home stock market based on its past performance.

recent foreign stock market performance, and to be negative for recent US stock market performance.

Regressions V and VI in table 3 report the results for the three expectation variables. The 1-month exchange rate change variable appears to have some explanatory power (with a t-value of -1.704) on the change in the ADR's premium. The 6-month exchange rate change has much lower explanatory power, with a t-value of -0.553. In contrast to the 1-month exchange rate change, the 1-month stock market return variable has a marginally stronger explanatory power than the 6-month variable. The 1-month home market return has a t-value of 5.25. On the other hand, the 1-month US market return has a t-value of 3.84, but surprisingly with the sign contradictory with our expectation. Since the dependent variable is the change in the ADR premium from one month to the next, we suspect that the contemporaneous exchange rate and stock market is more relevant information, thus we observe much stronger effect in the 1-month variables compared to the 6-month variables.

More importantly, the qualitative results about the liquidity effects should not alter significantly after the inclusion of these expectation variables. According to the results in table 3, the coefficients $\hat{b}_1, \hat{b}_2, \hat{b}_3, \hat{b}_4, \hat{b}_5$, remain as significant as before. This robustness check is important because it shows that the liquidity effects remain strong after the inclusion of the control variables.

From regressions IV, V and VI, it appears that liquidity in the host (i.e. ADR) market is more important than liquidity in the home market. We suspect that the asymmetry of the liquidity effects in both the host and home markets has to do with the fact that the premium is largely determined by the investors in the U.S. market, rather than those in the home market. Under normal conditions, investors in the U.S. market observe the price of the underlying asset, and collectively determine the level of the premium according to various factors they are faced with. It is also possible that home market investors observe the ADR's price in the U.S. market and then determine their demand for the underlying asset, but we believe that it is to a lesser degree compared to investors in the U.S. market doing the reverse. Based on our analysis, liquidity is an important factor in the pricing difference between the ADR and its home share. It is not surprising that the ADR's liquidity has stronger effects on its premium, since the latter is largely determined by ADR investors, who care much more about the liquidity in the ADR market rather than in the home market.

The findings are also economically significant. We find that the average premium of the most liquid ADRs (the top decile in terms of the Amihud measure) is 1.53 percent higher than the average premium of the most illiquid ones (bottom decile), with a *t*-statistic of 4.60. If the turnover ratio is used as the liquidity measure, the average premium of the most liquid ADRs is 1.76 percent higher than the average premium of the most illiquid ones, with a *t*-statistic of 5.45.

4.4. Robustness Checks: Level Regressions

Using the change variables, our main conclusion of the results so far is that the liquidity metrics, especially those of the ADR (the ADR's Amihud measure, its turnover, and trading infrequency), appear to have the strongest effects on the ADR's premium. The liquidity measures in the home market also have an impact on the premium, but only to a lesser extent as measured by the respective *t* statistics. We argue that in subsection 4.1 that estimating the ADR premium – liquidity relationship using change variables is a better econometrics model. In this subsection, we nevertheless carry out the regressions of equation (5) using level variables, along with the control variables. Namely, we include $Z_{i,t}$, such as firm size and a number of country characteristics variables, which are relevant in determining the level of the ADR premium. However, these variables are to some extent time invariant, and thus do not appear in the change regressions.

We report the results of level regressions in table 4. Regression I – IV involves only the liquidity measures and the results are largely consistent with those in the change regressions. All liquidity measures, except for the ADR turnover ratio, have significant coefficients with the right sign. The ADR turnover ratio is not significant, although it also has the right sign.

Regression V and VI include the controls for expectations on exchange rate change, and the home and US market return. Again, we use the recent return as proxies for such expectations. We use 1-month variables in regression V, and 6-month variables in regression VI. In contrast to the change regressions, the 6-month variables seem to have stronger explanatory power. In the change regressions, we show that the 1-month variables help explain the monthly change in the ADR premium. It is probably not surprising that the 6-month variables have stronger effects in the level regression since the level of the ADR premium include the cumulative changes from previous months, and thus the longer-period variables have stronger effects. In regressions VII and VIII, we also use the 6-month variables as proxies.

We include the ADR size in regression VII. Size has been widely accepted as an important factor in most asset pricing models.[18] Previous studies (e.g., Pastor and Stambaugh (2003) and Acharya and Pedersen (2005)) also document a high correlation between firm size and liquidity, which is also the case in our sample as reported in table 2. To test whether our results in the previous sub-section are merely manifestations of the size effect, we add the ADR size (market capitalization of the shares in ADR form) as an additional independent variable and run the regressions once again. The results reported in regression VII of table 4 shows that the liquidity effects do not disappear after the ADR size is added to the regressions. Indeed, the coefficient estimates and t-values are virtually unchanged from regression VI to VII.

4.5. Robustness Checks: Country Characteristics

In this subsection, we control for a number of country-level characteristics to account for the home country's openness (as measured by intensity of capital controls, the

[18] Indeed, many asset pricing models such as that of Fama and French (1992) use size as a factor in explaining cross-sectional returns.

transparency and credibility of its accounting standards, the efficacy of its judicial system, corporate governance variables such as anti-director rights), as well as its market restrictions (measured by restrictions on short-sales constraints and stock ownership concentration). On the one hand, firms from the emerging economies may have a larger ADR premium, since they often present high barriers for arbitrage trading between the share and the ADR. On the other hand, these economies are also likely to have weaker corporate governance and less efficient investor protection; therefore, international investors might demand a discount on ADRs from these countries. Thus, the overall effects of some of these country characteristics may not be clear.

First, the presence of short-sales restrictions in a country might explain the deviation of ADR price from home share price. Bris *et al.* (2002) provides in formation on short-sales restrictions (represented as 0 or 1) on most of the ADR-issuing countries in our dataset. La Porta *et al.* (1998) shows that investors investing in a foreign country are usually entitled a very different set of rights. These rights determine the level of investor protections and might therefore explain part of the ADR premium. Among these variables, anti-director rights (AD) indicates how much a country's legal system favors minority shareholders, and takes a value between 0 and 5. The quality of accounting standards (AS) is another variable, based on a proprietary index published by the Centre for International Financial Analysis and Research. It rates the countries' disclosure coverage, by counting how many accounting items firms are required to disclose, among 90 selected items. In addition to these variables, a more comprehensive account of a country's overall legal environment has been studied by Berkowitz *et al.* (2000). They computed a legality index for most world economies by incorporating the efficiency of their judiciary system, rule of law, corruption index, risk of expropriation, and risk of contract repudiation. Overall, we consider these variables, jointly, provide an objective measure of a foreign market's development.

Besides issues relating to market development, the ADR premium could be associated with the corporate governance concerns of international investors. Foreign investors may be concerned if the market is characterized by highly concentrated ownership, particularly by domestic business groups with economic and political clout in the home country. Again, La Porta *et al* (1998) provides a measure of the presence of such large shareholders. It is the defined as the average percentage of common shares owned by the 3 largest shareholders in the ten largest non-financial, privately-owned-domestic firms in a given country. It is reasonable to expect a high ownership concentration could be related positively to the ADR premium. We have included this variable in our cross-sectional studies.

Even if a foreign market is highly developed and open, the securities market itself might exhibit a high degree of firm-level informational asymmetry. Morck *et al.* (2000) computed, for most countries under our studies, a synchronicity measure, which corresponds to the adjusted R^2 of regressing each stock's return on its home market index and U.S. market index. The higher is this measure, the lower is the extent that firm-specific information contributes to stock price movements. Foreigners might refrain from investing directly in a certain country's shares, because the market is characterized by a high degree of informational asymmetry. Therefore, we expect this measure to be negatively related to ADR premium.

Finally, we use a simple measure of the intensity of capital controls, the Edison-Warnock Restriction (EWR) measure, in our regression model. The measure, constructed by Edison and Warnock (2003) is essentially the portion of the domestic shares that foreigners may own, and is computed based on the market's openness and the stock- and industry-specific limitations[19]. A value of 0 represents a completely open market and a value of 1 means a completely closed market. Their study only covers emerging markets from January 1989 to December 2000, but not the developed markets. Based on our judgment, we assume a value of 0 for all the developed markets in our sample since they are all highly liberalized markets[20].

Regression VIII in table 4 reports the regression result with the country variables. Since most of the country variables are correlated with the level of development of the country's economy and its capital market, these variables (except for the shot-sell constraint variable) are highly correlated among each other. Including them together in the same regression potentially creates a serious problem of multi-collinearity. To avoid this problem, in regression VIII, the values of these variables are actually the residuals of each variable regressed on the other country variables. The regression is also carried out

[19] The market's openness is based on the ability of foreigners to buy and sell shares and repatriate capital. The stock- and industry-level openness is based on industry, corporate by-laws, and corporate charter limitations on foreign ownership. See Edison and Warnock (2003) for details about the construction of this measure.

[20] Given the value of the EWR measure is around 0.10 for some of the emerging markets, we believe that the value should fall in between 0 and 0.10 for developed markets. Assuming a value of 0 for all developed markets might introduce some bias. However, the bias appears to be minor since in a robustness test, we also assume a EWR value of 0.05 or 0.10 for all developed markets and get similar results.

without the constant term as it appears that the country variable residuals are still highly correlated with the constant term. With the inclusion of these variables, the liquidity effects do not seem to disappear. The ADR Amihud measure, the ADR turnover ratio and the home share turnover ratio still have significant explanatory power. However, the sign of the trading infrequency, whose strength was weak even early, is reversed and inconsistent with our hypothesis.[21]

In regression IX, we use country dummy variables as a catch-all variable for all country-specific variables. In this regression, all liquidity measures have the right signs with the home share turnover ratio and trading infrequency being significant at the 5% confidence interval. The other liquidity measures are marginally significant. Essentially, this "reduced form" representation of the country-specific openness and transparency variables, through a dummy variable, reduces the problem of multi-collinearity leading to a cleaner relationship between the premium and the liquidity variables.

5. Conclusion

Liquidity is generally viewed as a positive characteristic of a traded asset in positive net supply. The higher liquidity of a given asset should, therefore, be reflected in a higher asset price or lower required return. In this paper, we investigate the liquidity effect in

[21] This may be due to the fact that in several emerging economies, which are not fully open or transparent, the stocks of the major firms (that are usually the ones that are listed as ADRs) are actively traded, with low levels of trading infrequency. Also, since they represent the larger firms in these countries, the frequency of trading in the ADR market is usually high.

asset pricing using a large sample of ADRs. The ADR market is ideal for testing the liquidity effect, since it consists of securities with identical cash flow rights to their counterparts in the home market. Consequently, the premium in the ADR market, in relation to its home market counterpart, can provide interesting clues regarding the effects of liquidity on asset pricing. The other aspect of the ADR market that makes it interesting for such empirical testing is its size and growing importance in the context of global equity markets, contributing in mid-2004 to about 5% of all trading value in the U.S. equity markets.

In an integrated market without frictions and time zone differences, there should be no premium or discount for the ADRs. In reality, financial markets are, to some extent, segmented, and are affected by many market frictions such as international capital controls, differences in taxes, security laws, and trading regimes, between the host and home markets. In this paper, we focus mainly on the liquidity differences between the two markets, and their effects on the pricing of an ADR in relation to its underlying share. We examine the cross-sectional relation between the *change* in premium and the *change* in liquidity. Consistent with the liquidity hypothesis, we find that increase in the ADR premium is associated with increase in ADR liquidity. An increase in premium is also associated with decrease in home share liquidity, albeit to a lesser degree, compared to ADR liquidity. In the robustness check with level regressions, the liquidity effects remain strong, even after we control for ADR size, and investors' expectations regarding future exchange rate movements, home stock market performance, and various measures of country characteristics.

Our study has several implications for firms, regulators and investors. As firms from more and more countries expand their investor base by listing in overseas markets, particularly in New York, London and Singapore, the role of liquidity in the pricing of their securities is bound to command attention. Our study has implications for the design of depositary receipt programs, both American (ADR) and Global (GDR), since it provides indirect clues regarding the optimal size of these offerings. A small size for an ADR program in relation to its total amount outstanding may have large illiquidity effects. By the same token, a large ADR program may cause the liquidity in the home market to dry up. Caution must be exercised in ensuring that the amounts outstanding in the two markets are well balanced.

An interesting question arises in the context of liquidity effects in dually listed securities, in particular with regard to how liquidity is transferred from one market to another. This also raises the possibility of arbitrage by forecasting movements in one market, based on the price changes in the other, especially when there are differences in the time zones where the two markets are situated. These effects are likely to be more significant for firms from the emerging markets. We leave these questions to future research.

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Table 1: Summary Statistics: January 1981 - December 2003

This table reports the number, the average market capitalization and the premium statistics for the ADRs of each country included in the study. The data are obtained from two sources: the ADR data are obtained from CRSP; the home share data are obtained from Datastream. The sample includes 401 pairs of ADR and corresponding underlying shares in the home market from 23 countries, from January 1981 to December 2003. Column 1 reports the total number of ADRs included in the study for each country. Column 2 reports the average number of ADRs in each month. The next four columns refer to the central tendencies of the monthly market capitalization (MV) and the premium, for each country, using the average of daily observations. The 4th (5th) column of the table represents the average of each country's monthly median (mean) MV in millions of US dollar throughout the sample period. The 6th (7th) column is the average of each country's monthly median (mean) premium in percentage throughout the sample period.

	# of ADRs		Average MV (Million)		Average Premium (%)	
Country	Total	Average	Median	Mean	Median	Mean
UK	92	35	3410	8743	0.36	-0.76
France	29	12	6772	12488	-0.02	-0.12
Germany	24	6	8465	12798	0.04	-0.44
Netherlands	13	5	7843	9251	-10.54	-11.81
Italy	11	5	6995	11371	0.06	5.40
Sweden	8	4	3210	5970	0.04	0.13
Switzerland	11	5	4954	11298	-0.18	-0.26
Ireland	10	5	1968	2673	0.51	0.89
Spain	6	4	38603	41312	-0.26	-0.02
Israel	6	5	397	570	7.10	7.09
Norway	7	3	3610	4701	-0.26	-0.79
Finland	5	2	2734	11268	0.14	0.17
Japan	32	24	9047	14925	-0.04	4.07
HK	23	8	4609	7479	-0.15	-0.37
Korea	9	3	11164	10644	6.72	4.54
India	10	6	5014	6541	21.53	25.48
Taiwan	10	3	7286	10364	6.93	11.14
Australia	24	11	2479	4397	-0.13	-6.45
Mexico	18	7	1223	3026	-0.15	0.25
Chile	17	10	853	1428	2.03	2.03
Brazil	12	5	840	1523	-2.44	-17.90
Argentina	10	7	2482	3558	-0.73	-0.14
South Africa	14	6	1007	1674	0.24	1.40
All	**401**	**183**	**3173**	**8512**	**-0.01**	**1.13**

Table 2: Liquidity and Turnover Characcteristics of ADRs and their Underlying Securities

This table provides the basic statistics of the liquidity and turnover characteristics of ADRs' and their underlying securities. The data are obtained from two sources: ADR data are obtained from CRSP; home share data are obtained from Datastream. The sample includes 401 pairs of ADR and corresponding underlying shares in the home market from 23 countries. Individual ADRs and home shares' Amihud (2002) liquidity measures are defined as the ratio of absolute daily return and dollar volume, and are scaled by 1000. Daily measures are then averaged to provide monthly series of the ADRs in our study. Turnover is defined to be number of shares traded divided by the total number of shares outstanding. Trading infrequency is obtained by dividing the number of days that the ADR is not traded by the number of trading days in a given month. Panel A provides the time series averages of the monthly cross-sectional mean, median, standard deviation, maximum and minimum values. Panel B provides the time series averages of the monthly correlations among the liquidity measures and size.

Panel A

	Mean	Median	Std	Max	Min
Home Share Amihud Measure	0.0332	0.0002	0.1730	1.9724	0.0000
Home Share Turnover	0.0093	0.0022	0.0772	1.0311	0.0001
ADR Amihud Measure	0.0719	0.0052	0.2617	2.4288	0.0000
ADR Turnover	0.0137	0.0052	0.0510	0.6280	0.0003
ADR Trading Infrequency	0.1147	0.0336	0.1724	0.8202	0.0180

Panel B: Correlations

	HS Amihud	HS Turnover	HS Size
Home Share Amihud Measure	1	-0.0081	-0.4139
Home Share Turnover	-	1	-0.2776
Home Share Size	-	-	1

	ADR Amihud	ADR Turnover	ADR Size	ADR TI
ADR Amihud Measure	1	-0.0344	-0.4662	0.4688
ADR Turnover	-	1	-0.1869	0.0077
ADR Size	-	-	1	-0.5614
ADR Trading Infrequency	-	-	-	1

Table 3: Liquidity Effects: Regressions Using Change Variables

This table summarizes the pooled regressions of the change in the ADR premium on the change in the ADR and home share liquidity measures, the change in the ADR trading infrequency, as well as other control variables, which include the exchange-rate proportionate change in the past 1 (6) months, and home and US stock market return in the past 1 (6) months. The data are obtained from two sources: ADR data are obtained from CRSP; home share data are obtained from Datastream. The sample includes 401 pairs of ADR and corresponding underlying shares in the home market from 23 countries, from January 1981 to December 2003. Individual ADR and home shares Amihud (2002) liquidity measures are defined as the ratio of absolute daily return and dollar volume, scaled by 1000. Individual ADRs and home turnover ratios are defined as the ratio of dollar trading volume to the dollar amount outstanding in each market. The exchange-rate return is defined as the percentage return of the current month's average daily exchange rate relative to average daily exchange rate in previous month (or 6 months ago), where the exchange rate is defined as the number of units of foreign currency per unit of U.S. dollar. The stock market return is defined as the current month's average daily index level relative to the average daily index level in previous month (or 6 months ago). The coefficient estimates are the OLS estimates from the pooled regressions of the panel data. The values in italics are the corresponding t-statistics for the coefficient estimates using Rogers standard errors clustered by firm.

	I	II	III	IV	V	VI
Intercept	0.000	0.000	0.000	0.000	0.000	0.000
	0.449	***0.630***	***0.703***	***0.464***	***-0.480***	***-0.311***
Change in ADR Illiquidity (Amihud)	-0.004			-0.004	-0.004	-0.004
	-2.509			***-2.426***	***-2.377***	***-2.400***
Change in Home Share Illiquidity (Amihud)	0.002			0.002	0.002	0.001
	0.605			***0.618***	***0.600***	***0.459***
Change in ADR Liquidity (Turnover)		0.010		0.020	0.034	0.040
		1.083		***2.036***	***3.559***	***3.594***
Change in Home Share Liquidity (Turnover)		-0.009		-0.009	-0.009	-0.009
		-1.567		***-1.602***	***-1.464***	***-1.423***
Change in ADR Illiquidity (Trading Infrequency)			-0.004	-0.005	-0.003	-0.006
			-1.286	***-1.236***	***-0.783***	***-1.386***
1-Month Exchange Rate Return					-0.014	
					-1.704	
1-Month US Stock Market Return					0.043	
					5.251	
1-Month Home Stock Market Return					0.100	
					3.841	
6-Month Exchange Rate Return						-0.001
						-0.553
6-Month US Stock Market Return						0.005
						1.924
6-Month Home Stock Market Return						0.007
						1.138

Table 4: Robustness Check: Regressions Using Level Variables

This table summarizes the pooled regressions of the ADR premium on the liquidity measures of ADR, home share and the home market. The liquidity measures include the Amihud (2002) liquidity measure, turnover ratio and ADR trading infrequency. The regressions also include other control variables, such as ADR size, the exchange-rate proportionate changes in the past 1 (6) months, and home and US stock market return in the past 1 (6) months. The control variables also include country characteristics variables such as short-sell constraint, legality index, accounting standard, anti-director rights, ownership concentration, synchronicity with the US market and the EWR measure of capital control intensity. The data are obtained from multiple sources: ADR data are obtained from CRSP; home share data are obtained from Datastream. The sample includes 401 pairs of ADR and corresponding underlying shares in the home market from 23 countries, from January 1981 to December 2003. Individual ADRs and home shares' Amihud (2002) liquidity measures are defined as the ratio of absolute daily return and dollar volume, and are scaled by 1000. Individual ADR and home share turnover ratios are defined as the ratio of dollar trading volume to the dollar amount outstanding in each market. The exchange-rate return is defined as the percentage return of the current month's average daily exchange rate relative to average daily exchange rate in previous month (or 6 months ago), where the exchange rate is defined as the number of units of foreign currency per unit of U.S. dollar. The home stock market return is defined as the current month's average daily index level relative to the average daily index level in previous month (or 6 months ago). The values in italics are the corresponding t-statistics for the coefficient estimates. Regression V uses 1-month exchange rate return and stock market return. Regressions VI, VII and VIII use 6-month exchange rate return and stock market return.

	I	II	III	IV	V	VI	VII	VIII	IX
Intercept	0.003	0.002	0.001	0.004	0.002	0.001	0.015		0.002
	5.239	***3.961***	***1.779***	***6.613***	***3.461***	***1.974***	***3.181***		***3.085***
ADR Illiquidity (Amihud)	-0.006			-0.004	-0.003	-0.003	-0.003	-0.004	-0.003
	-2.948			***-2.142***	***-1.993***	***-1.672***	***-2.098***	***-2.270***	***-1.862***
Home Share Illiquidity (Amihud)	0.007			0.008	0.008	0.006	0.006	0.003	0.003
	2.679			***2.991***	***2.857***	***2.316***	***2.203***	***0.822***	***1.357***
ADR Liquidity (Turnover)		0.050		0.051	0.151	0.190	0.188	0.045	0.051
		1.533		***1.528***	***4.952***	***6.398***	***6.370***	***4.346***	***1.558***
Home Share Liquidity (Turnover)		-0.045		-0.046	-0.047	-0.037	-0.037	-0.037	-0.023
		-2.729		***-2.747***	***-2.713***	***-2.327***	***-2.326***	***-2.275***	***-2.190***
ADR Illiquidity (Trading Infrequency)			-0.012	-0.012	-0.005	-0.007	-0.011	0.001	-0.011
			-6.364	***-5.112***	***-2.637***	***-3.243***	***-5.314***	***0.796***	***-4.288***
1- (or 6-) Month Exchange Rate Return					-0.017	-0.009	-0.009	-0.007	
					-0.913	***-1.686***	***-1.604***	***-0.402***	
1- (or 6-) Month US Stock Market Return					0.033	0.025	0.025	0.048	
					2.848	***4.899***	***4.856***	***1.504***	
1- (or 6-) Month Home Stock Market Return					-0.017	-0.014	***-0.014***	0.023	
					-0.323	***-1.102***	***-1.107***	***0.631***	
Log(ADR size)							-0.001	0.002	0.000
							-2.719	***6.287***	***7.287***
Short-sell Constraint								-0.039	
								-7.372	
Legality Index								0.015	
								4.067	
Accounting Standard								0.003	
								2.085	
Anti-director Rights								-0.006	
								-1.005	
Ownership Concentration								-0.180	
								-3.427	
Synchronicity with the US Market								0.112	
								0.639	
EWR								0.100	
								0.931	