Price Discovery, Foreign Ownership, and Rule of Law

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Abstract

This paper aims to explore two issues. First, we examine the relation between intraday price discovery and proxies for financial openness or investor accessibility for a large cross-section of 23 emerging markets. Our sample covers 1,504 stocks over a period of eight months, from 2006 to 2007. We measure price discovery by weighted price contribution. We find that there is a reliable relation between early price discovery and direct foreign ownership in the underlying stocks after controlling for other factors. Greater price discovery is affiliated with a more significant presence of foreign investors in the home markets. Second, we extend the literature on law and finance to studies of market microstructure. We study the relation between the quality of legal environment to the speediness of price discovery. We find that rule of law condition plays an important role in facilitating rapid price discovery. Our finding establishes a positive link between the quality of legal environment and efficiency of financial markets, where the latter is important for the ultimate goal of economic development.

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1. Introduction

Price discovery is a process by which new information is impound into security prices as markets attempt to find equilibrium prices, (Schreiber and Schwartz (1985)). It has always been a fundamental issue in studies of market microstructure. Numerous theoretical models have studied the role and discretionary behavior of various participants such as market makers, informed investors, and uninformed investors under alternative trading mechanisms including quote- and order-driven markets.[1] The empirical literature on price discovery is extensive. Broadly speaking, these empirical studies can be categorized into (i) price discovery during the trading day, including price discovery by trade size (Barclay and Warner (1993)) and by investor types (Chakravarty (2001)); (ii) price discovery during the pre-open and after hours period (Biais, Hillion, and Spatt (1999); Cao, Ghysels, and Hatheway (2000); Barclay and Hendershott (2003))[2]; (iii) price discovery on alternative trading venues (Huang (2002); Barclay, Hendershott, and McCormick (2003)) and exchanges in different geographic locations (Garbade and Silber (1979); Hasbrouck (1995); Harris et al. (1995)).

In this paper, we intend to address two issues. First, we examine the relation across emerging markets between price discovery and the degree of market openness or investor accessibility. Developed markets have captured much attention in the existing literature of price discovery. This paper is part of the growing literature on financial markets in emerging markets. We study a cross-section of 23 emerging markets which are typically characterized by more severe barriers to investment or tighter controls on foreign capital flow, less market transparency, larger transaction costs, and higher return volatility. The majority of studies on emerging financial markets emphasize the impact of investment barriers on the cost of capital, market integration, foreign speculation, return volatility, liquidity, and expected returns. While global financial markets have become more liberalized and integrated over the past years (e.g., Bekaert and Harvey (1995, 1997, 2000); Bekaert, Harvey, and Lumsdaine (2002); Bekaert, Harvey, and Lundblad (2007)), there is little research on microstructure issues in emerging markets, as observed by Bekaert and

[1] See O'Hara (1995), Madhavan (2000), and Biais, Glosten, and Spatt (2005) for comprehensive expositions of a variety of theoretical models in market microstructure.

[2] Several other articles have examined the importance of preopening activities in the process of price discovery. See Stoll and Whaley (1990), Flood et al. (1999), Madhavan and Panchapagasen (2000), Davies (2000), and Ciccotello and Hatheway (2000).

Harvey (2003).[3] Our study aims to fill in this gap by linking price discovery to emerging market characteristics.

We wish to understand the relation between the timing of price discovery and proxies for financial openness or investor accessibility for individual firms across emerging markets. Splitting the trading day into *k* non-overlapping intervals, we measure intraday price discovery within each interval using the weighted price contribution (WPC), or the average fraction of the day's return attributable to that time interval. We hypothesize that price discovery early in the trading day is related to the openness of the market for an asset. We utilize several proxies for openness: the Standard & Poor's (S&P) investability index; foreign direct ownership in individual stocks; and dummy variables that represent the simultaneous trading of depositary receipts (DR) or cross-listed stocks in major international equity markets, in addition to additional control variables. The DR variable acts as a proxy for the availability of indirect foreign investment channels in emerging markets. We choose the WPC measure since it can easily provide estimates of price discovery for different intra-day intervals.[4, 5] A positive relation between early price discovery and the openness variables is consistent with foreign participation aiding rapid price discovery.

The second issue we intend to address is the relation between legal environment and price discovery. The law and quality of its enforcement and its implication a range of issues in finance has received much attention recently. For example, La Porta, Lopez-de-Silanes, and Shleifer (1999, 2002) study corporate ownership and government ownership of banking stocks. La Porta, Lopez-de-Silanes, Shleifer, and Vishy (1997, 1998, 2000a, 2000b) examine the issues related to external financing, investor protection, corporate governance, and dividend policy. Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2003) explore the effectiveness of courts as mechanisms of resolving disputes and show that the performance of court is determined by how the law regu-

[3] A few studies have compared trading costs for a large cross-section of emerging markets. Bacidore and Sofianos (2002), Jain (2001), Domowitz, Glen, and Madhavan (1998, 2001), Ghysels and Cherkaoui (2003), Chan, Menkveld, and Yang (2004).

[4] There are several alternative approaches to address the issue of price discovery. Biais, Hillion, and Spatt (1999) employ the unbiased regression approach to examine price discovery in the Paris Bourse. Hasbrouck (1991a, 1991b, 1995) develops an information share measure from a vector auto-regression framework. Hasbrouck (1995) and Harris et. al. (1995), and Huang (2002) adopt co-integration and error-correction models.

[5] A number of papers compare the price discovery process for cross-listed stocks simuotaneouly traded in domestic and foreign exchanges. See Werner and Kleidon (1996), Eun and Sabherwal (2003), and Halling, Pagano, Randl, and Zechner (2007).

lates their operation. McLean, Zhang, and Zhao (2011) investigate the effect of investor protection on investment, finance, and growth. We extend this strand of literature to price discovery in studies of market microstructure. We aim to explore the relation between various measures of the quality of legal environment on the speediness of price discovery.

Our study uses a broad and comprehensive sample of emerging markets. Our sample consists of 1,504 stocks included in the S&P Emerging Markets Database (EMDB) from the 23 emerging markets of Argentina, Brazil, Chile, China, the Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Pakistan, Peru, the Philippines, Poland, Russia, South Africa, Taiwan, Thailand, Turkey, and Venezuela.

A complication in studying intraday price discovery across a large number of different exchanges is the notable difference in total trading hours. It is not feasible to directly compare WPCs for a fixed period of time such as the first 30 minutes on different exchanges. To resolve this issue, we compute WPC for fixed fractions of the trading day. Total trading hours on each day is divided into quintile intervals and the corresponding WPC is calculated for each interval. By construction, the Barclay and Warner (1993) WPCs from each of the quintile intervals add up to a constant value of one over the course of a typical trading day. Higher values of WPCs earlier in the trading day imply lower values of WPCs later in the trading day. Cross-sectional, positive regression slopes on degree of openness earlier in the trading day imply negative regression slopes later in the trading day, or vice versa. Our hypothesis is that the regression slope will be positively significant earlier in the trading day.

We focus on the price-discovery during the open-to-close trading hours because (i) price discovery during this period accounts for the majority of the total price discovery during the close-to-close period; [6] (ii) control variables such as bid-ask spread and trading volume from the data feed are representative and can be accurately measured during the open-to-close intervals; and (iii) arrangement of pre-open and post-hour trading mechanisms vary from exchange to exchanges while the trading mechanism during the open-to-close hours are the standard via the

[6] The mean and median price discovery (WPC) during the open-to-close period are 76.9 and 78.3 percent, respectively. The corresponding WPC during the close-to-open period are 23.1 and 21.7 percent respectively.

continuous limit order book method for all 23 markets under investigation.[7, 8]

Our cross-sectional analysis of the factors that affect price discovery yields interesting insights on the role of the control variables including bid-ask spreads, return volatility, and number of analysts following each firm. In particular, early price discovery is negatively related to the level of spread and return volatility and positively related to the number of analysts following. More importantly, we find that among the three proxies that measure the degree of openness and foreign accessibility, direct foreign ownership by institutional investors is by far the most important determinant. The presence of a large percentage of stocks held by foreign investors seems to significantly facilitate the process of price discovery. We further test several alternative explanations for the role of foreign investors. These include the information acquisition cost (Boehmer and Kelley, 2009), competition among informed investors (Holden and Subrahmanyam, 1992), and analyst coverage channel (Brennan and Subrahmanyham, 1995). Our empirical evidence offers strong support for the information acquisition cost model. Foreign investors will focus on acquiring information on large ownership stocks, or concentrated ownership stocks. These stocks tend to reach equilibrium price level faster.

Our findings that accelerated price discovery is associated with more foreign investors complements those studies showing a lower cost of equity and slightly decreased return volatility after capital market liberalization in emerging markets (Bekaert and Harvey (1997, 2000))[9] as well as the study by Choe, Kho, and Stulz (1999) which finds no support for a destabilizing role by foreign investors in emerging markets. Evidence about the role of foreign investors in emerging markets is important in light of the debate on whether developing countries should impose tighter control and regulation on foreign capital inflow (Stiglitz, 1998).

With respect to various measures of legal environment examined in early studies, we ex-

[7] For example, on the Shanghai Stock Exchange in China, block trades are crossed in the 30 minute interval immediately after the market officially closed for trading. The price is set to be within a certain range of the closing price of the trading day. The block trade data are not released out side the stock exchange via Bloomberg. In Taiwan, odd-lot and block-trading have separate sessions after regular trading sessions are closed. In Brazil, after-hour trading is handled by the dealer market. On the Telaviv Stock Exchange, orders can be entered during the pre-open session, but no transaction can take place.

[8] Argentina and Brazil adopt a hybrid trading system. See The Handbook of World Stock, Derivative & Commodity Exchanges (2005) for more details.

[9] Unlike previous studies of emerging market volatility which usually focus on the changes in volatility subsequent to stock market liberalization, Bae, Chan, and Ng (2004) investigate the impact of investability on emerging market volatility. They report a positive relation between return volatility and investability.

amine the following variables, rule of law, legal origin, efficiency of the judicial system, risk of repudiation, risk of expropriation, and quality of a country's accounting standards, among others. We conclude that rule of law is an important determinant of the speediness of price discovery. Rule of law captures the perception of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement and property rights. A higher score in rule of law facilitate early price discovery. Legal origin assigns a value of 1 to civil law countries and a value of 0 to common law countries. Legal origin has a positive correlation of 0.32 with rule of law measure. Legal origin is important determinant of foreign ownership. U.S. mutual and pension funds, which account for the majority of foreign investors in emerging markets, tend to invest more in common law countries.

The rest of the article proceeds in the following way. Section 2 describes the data sources and sample construction and provides summary statistics on firm characteristics and measurements of domestic ownership and foreign investor accessibility. Section 3 discusses the detailed procedure for calculating the weighted price contribution. Section 4 documents empirical properties of intraday price discovery for our sample of emerging market exchanges. Section 5 studies the relation between WPCs and a number of variables meant to measure liquidity, domestic ownership, the extent participation by foreign investors, and legal environment. Section 6 addresses the issue of endogeneity. Section 7 address the issue of omitted confounding variable. Section 8 concludes the paper.

2. Data Sources, Sample Construction, and Firm Characteristics

2.1 Data Sources

Our data come from numerous sources. The first source is the Standard and Poor's Emerging Markets Database, (see Standard and Poor's (2000)). This dataset provides comprehensive accounting and market information for emerging markets. As of October 2007, it covers more than 2,200 firms located in 35 countries. We use it to obtain data on investability, industry sector, equity market capitalization in U.S. dollars, number of shares outstanding, and exchange rates.

Our second data source is Bloomberg. We rely on Bloomberg's real-time data feed data to obtain intraday trade and quote data. The transaction data specifies the security identifier,

trading date, time of bid and ask quotes to the nearest second, bid price, bid size, ask price, ask size, trade price, trade size, exchange code, and condition code of bid and ask quotes.[10]

Of the 35 countries in the EMDB, tick data are unavailable for 10 countries: Bahrain, Jordan, Morocco, Nigeria, Oman, Portugal, Saudi Arabia, Slovakia, Sri Lanka, and Zimbabwe. In addition, the EMDB stopped collecting data from Greece in its most recent release. This leaves us with a sample of 24 emerging markets. After eliminating stocks from these countries, the tick dataset has information on 1,616 of the 1,976 stocks in these 24 markets. In addition, the 15 Colombian stocks have intraday trade data but not quote data and we dropped them from our sample. We are left with a final sample of 1,601 stocks from 23 countries.

Our sample period covers approximately eight months, from August 29, 2006 to April 27, 2007. Due to data availability, countries differ in their starting and ending dates. For most countries, the starting date is either August 29, 30, or 31, 2006 and the ending date is April 27, 28, or 29, 2007. This results in the number of trading days across markets ranging from a median of 144 days to a median of 168 days. The median number of trading days varies from 144 for Egypt to 168 for Korea over the sample period. One reason is that there are different holidays in the various countries. Additionally, different markets had histories of different lengths available from Bloomberg when we started collecting data. [11]

The third data source is the Osiris Ownership database developed by Bureau van Dijk in Brussels. The main source of the non-US ownership includes annual report, private correspondence, stock exchange, information providers, company web-sites, press news, and other sources. The primary objective of the Osiris Ownership database is to track control relationships.[12] We search for domestic ownership using the dataset, where the domicile country of the underlying stocks is the same as the domicile country of the investors. The data are for an eight-month window prior to April 30, 2007. The investors are classified into the following categories: banks,

[10] We set the exchange specification to be "composite" when we download the tick data from Bloomberg. Therefore the tick data contain all trades and quotes from different exchanges within each market.

[11] We screen all the intraday data through the following filters: (i) Trades and quotes must be recorded during the hours for which the exchange is open and have positive prices and positive shares quoted or traded. (ii) If a quote is not the first quote of the day, its price must be within a range of 50% ~ 150% of its previous quote. (iii) If a trade is not the first trade of the day, its price must be within a range of 50%~150% of the price of the trade prior to it.

[12] See the manual for BvD Ownership Database.

financial, industrial, and insurance companies, mutual funds, pension funds, and trustees, foundation and research institute, pubic authority, states, and governments, one or more known individuals or families, other unnamed shareholders in aggregate, employees, managers, and directors, private equity firms, and venture capital. We exclude public authority, states, and government in our measure of domestic ownership. For our sample of 1,504 stocks, mutual funds, pension funds, and trustees account for 29% of all institutions; banks, financial firms, insurance firms account for 24%; industrial firms account for 26%; one or more named individuals or families account for 14%.

The third data source is the FactSet Ownership database. This database provides information on direct global institutional ownership of local stocks. Since institutions have a greater presence in the U.S. than in other nations, FactSet ownership includes a U.S. bias. We use data on holdings of the two largest categories of institutions in the FactSet Ownership database, open ended mutual funds and offshore funds, which make up 77% of all institutions in the database. We have also estimated the results including closed end funds (the third largest set of institutions) and all funds. The results are robust to these permutations. The data are for the most recent reports filed within an eight-month window prior to April 30, 2007 (our results are robust if we choose a 12-month window prior to April 30, 2007).

Our fourth data source is the list of depositary receipts (DRs) maintained by the Bank of New York. The DRs are used by emerging markets to tap foreign investors who prefer to buy and sell in their own home markets. We identify firms in our sample that issue ADRs (DRs issued in the U.S.) and DRs. The list contains information on the location of the DR listing and its effective dates. The listing exchanges include the American Stock Exchange, the London Stock Exchange, the Tokyo Stock Exchange, the Luxemburg Stock Exchange, Nasdaq, the New York Stock Exchange, OTC, and PORTAL (NASDAQ's market for privately placed equities). We also search for cross-listed firms in our sample. We rely on Facsetset's definition of cross-listed stocks. A stock is considered to be cross-listed when there is a class of share whose exchange country is different from its domicile country.

Our fifth source is the I/B/E/S dataset. It contains analyst coverage information. From this dataset we obtain data on the number of analysts who cover the stock, or report earnings estimates, during the 8-month period from September 2006 to April 2007.

2.2 Sample Construction

We report results based on the sample for which data are available for all variables. The sample has 1,601 stocks that span 23 countries and ten industries.[13] The industries are consumer discretionary, consumer staples, energy, financials, healthcare, industrials, information technology, materials, telecommunication services, and utilities. We apply the following filter rules to the sample stocks. First, we screen out infrequently-traded stocks by eliminating stocks with fewer than five daily trades on average. This excludes 81 stocks. Second, we screen out stocks with very large percentage quoted spreads, that is, spreads of 10% or larger. This eliminates an additional 5 stocks. Finally, we eliminate an additional 11 stocks that experienced stock splits or changes in minimum trading units during the sample period.[14] Panel A of Table 1 summarizes the original sample of stocks from each country and the number of stocks eliminated following each of the above four filters. Among the 1,504 stocks remaining, Korea has the largest number of stocks (257), followed by China (220), India (153), Taiwan (134), and South Africa (102).

2.3 Firm Characteristics

Panel A of Table 2 provides summary statistics on several firm characteristics. Market capitalization is the end-of-month market value at the end-of-month exchange rate of the local currency. The monthly U.S. dollar monthly market value is averaged over the sample period for each stock. The Average firm size, reported in the first column of Table 2, is the cross-sectional mean across all stocks within each country. The daily stock price (column 3) is calculated as the product of daily closing quote midpoints times the exchange rate. The U.S. dollar daily stock price for each firm is averaged over the sample period. The average daily stock price is the cross-sectional mean across all stocks within each country. Similarly, a cross-sectional mean of average daily U.S. dollar trading volume and daily return volatility over the sample period are reported. Return volatility is measured by the standard deviation of daily returns calculated using closing quote midpoints over our entire sample period. The next column displays the cross-sectional mean of quoted percentage bid-ask spread from all stocks in each country. The intra-

[13] The distribution of sample stocks by country and industry classification is available upon request.

[14] The split flags are from the EMDB dataset. We also collect information on splits and changes in minimum trading unit from Bloomberg News Service.

day percentage quoted spreads are first averaged for each day, and then the daily percentage quoted spreads are averaged over the sample period. Finally, we take the cross-sectional mean of the daily average quoted spread.

Panel A of Table 2 shows that firm size and average stock price are largest for Russian firms, with a mean market value of $40.8 billion and mean stock price of $82.30. Czech stocks are most actively traded, on average, with a mean daily dollar volume of $19.8 million. Stocks from Venezuela, China, and Brazil are most volatile. The mean daily return standard deviations for stocks in these countries all exceed 2.9%. Percent quoted spreads are lowest for Indian stocks, with a cross-sectional mean of 0.17%. The percentage quoted spread is highest, at 2.68%, for Venezuelan stocks. The relatively higher quoted spread for Latin American countries is consistent with findings from Bacidore and Sofianos (2002) and Domowitz, Glen, and Madhavan (2002).

2.3 Measurement of Domestic Ownership

Panel B of Table first reports the average value for the following measures of domestic ownership, number of investors, domestic ownership by all investor types except public authority, states, and government, top-3 and top-5 domestic investors, domestic fund ownership, and Herfindahl concentration index. In general, the average number of domestic investors is relatively small, ranging from the smallest value of one for Indonesia, Russia, Venezuela, and Israel to the largest value nine for Malaysia. This is due primarily to the fact that the Osiris database focuses on control ownership and therefore tracks the major shareholders only. However, the average percentage ownership is high. For all 1,504 stocks, the average domestic ownership is 16%. The average ownership by domestic funds is 2.63%. The domestic Herfindahl concentration index is much higher than Herfindalh concentration index constructed from foreign ownership.

2.4 Measurement of Foreign Investors Accessibility

Table 2 also summarizes two measures of access to, and participation in, a particular company's stock by foreign investors. The first measure is the investability index computed by S&P. This index measures the ability of foreign investors to trade the stock on local exchanges and to repatriate their funds. It incorporates foreign ownership restrictions by accounting for the presence of corporate by-laws, corporate charters, or industry limitations on foreign ownership.

The index ranges from zero to one and indicates the percentage of possible legal foreign ownership of the local stock. Among the 23 countries in Table 2, Poland has the highest average registered investable index level of 1.00, followed by Taiwan (0.80) and South Africa (0.69). Pakistan and Venezuela have the lowest reported average investable index level of 0.05 and 0.21. China has a relatively low average investability index (0.09). Domestic markets or A-shares are only available for Chinese citizens. Foreigners who would like to invest in Chinese stock markets can buy H-shares listed in Hong Kong or N-shares listed in New York. Some stocks in China issue both A- and H-shares.

The second measure is direct foreign ownership in domestic markets. We construct this measure from the FactSet Ownership Dataset over an 8-month period from September 2006 to April 2007. Table 2 reports the cross-sections average level of foreign ownership for each market, which ranges from 0.79% for Pakistan to 15.76% for Hungary. Among the four regions classified in the sample, Latin American countries tend to have less direct foreign investment in their stock markets. The average number of foreign investors is much larger than the average number of domestic investors. This is due primary to the compulsory nature of the 13f reports which are the ultimate source of the Factset Ownership database. However, the average level of foreign ownership is much lower than the average domestic ownership, being 6.16% for all 1,504 stocks. As a result, the Herfindahl concentration index from foreign ownership is much smaller.

Instead of direct investment in the underlying stocks, depositary receipts (DRs) and cross-listed shares provide international investors an alternative or indirect channel to buy stocks in emerging markets. The number of DRs and cross-listed shares that each country has in New York, London, Tokyo, and other international markets is reported in Table 2. The number of depositary receipts varies considerably across countries. Not surprisingly, Chian, Taiwan, India, Brazil, South Africa, and Korea have the highest number of DRs or cross-listed shares. Thailand and Venezuela have only two DRs listed overseas.

Finally, the last column of Table 2 summarizes the median number of analysts following each stock. Numerous studies have documented that the amount of analyst coverage is positively related to the size, prominence, and popularity of stocks in the home markets of both developing and emerging markets. Our results indicate that the amount of analyst coverage of most stocks is less than 10, with the exception of Indonesia.

3. Weighted Price Contribution Measure

We begin the analysis by estimating time-of-day price discovery via the weighted price contribution, or WPC. The weighted price contribution decomposes the return over a time period into components attributable to *k* categories, defined by the categories of interest for the particular analysis. For example, Barclay and Warner (1993) first propose the WPC measure to identify which trade size groups move prices. In their case the categories are defined as small, medium, and large size trades. They find that most of the price discovery is from medium-sized trades. Chakravarty (2001) defines categories by trade size and by whether the initiator of the trade was an institution. Medium-sized trades by institutions contribute disproportionately large cumulative price contributions. Cao, Ghysels, and Hatheway (2000), Huang (2002), and Barclay and Hendershott (2003) use the weighted price contribution measure to examine the contribution of NASDAQ pre-open market, NASDAQ after hours trading, and ECN and NASDAQ market maker quotes to price discovery.

Our study is motivated by the evidence that price discovery process seems to be related to trading (e.g. French and Roll (1986)). We wish to see if the openness of capital markets is related to the timing of price discovery across the trading day. In particular, do more open markets lead to earlier price discovery?

We construct the WPC measure for stock *i* over the k^{th} interval of the trading day in the following way:

$$WPC_{i,k} = \sum_{t=1}^{T} \frac{|\, r_{i,t} \,|}{\sum_{t=1}^{T} |\, r_{i,t} \,|} \cdot \frac{r_{i,t,k}}{r_{i,t}} \quad , \tag{1}$$

where $r_{i,t}$ is the return on stock *i* on day *t*, and $r_{i,t,k}$ is the return on stock *i* in interval *k* on day *t* (for $k = 1,..,K$, and $t = 1, \ldots, T$).[15] The weighting in Equation (1) is designed to give lower weight to days with little relevant news (measured by returns close to zero) and higher weight to

[15] Stock/Day observations for which returns $r_{i,t} = 0$ are deleted from the sample.

days with large absolute returns. We illustrate using China as an example. On the Chinese market, trading sessions are from 9:30 to 11:30 in the morning and from 13:00 to 15:00 in the afternoon, resulting in 4 total trading hours. Therefore, if we choose to look at 5-minute intervals, $K = 48$.[16] The term $r_{i,t,k} / r_{i,t}$ measures the contribution of the return in the k^{th} interval relative to the open-to-close return $r_{i,t}$ on day t. The term $| r_{i,t} | / \sum_{t=1}^{T} | r_{i,t} |$ weights the relative importance, over the T day period of the open-to-close return on each trading day t. This term measures the contribution of the absolute return during day t to the cumulative absolute return over the entire sample period. When a large absolute open-to-close occurs on a particular day, the relative contribution of 5-minute returns on that trading day will account for more significance.

4. Intraday Price Discovery

Trading hours vary from exchange to exchange in our sample of 23 emerging markets. In Table 3, we provide a summary of limit order book trading sessions and total limit order book trading hours for 23 emerging markets.[17] The data source is the Handbook of World Stock, Derivative & Commodity Exchanges (2005). We confirm the trading hours by a plot of five-minute number of trades for two active stocks in each market. As can be seen from the table, the trading hours range from 2.5 hours for the Philippines to 8.25 hours for Russia.[18] The last column reports the length of overlapping trading hours with the NYSE session in each market. Among 23 markets, 6 Latin American countries have the longest overlapping trading hours, while nine Asian markets, Egypt, and Turkey do not overlap with the NYSE trading hours.

4.1. Intraday WPC by Quintile Trading Intervals

[16] The five-minute returns are calculated using prices interpolated from the most recent transaction prices surrounding the integer five-minute cutoff points. For example, if the last transaction price prior to 11:00 am is 20 yuan at 10:59:55 and the first transaction price after 11:00 am is 21 yuan at 11:01:05, then the interpolated price at integer cutoff point 11:00 is $65/(65+5) \cdot 20 + 6/(65+5) \cdot 21 = 20.07$. The nearby prices are weighted by the inverse of the time elapsed relative to the integer cutoff point of 11:00.

[17] In unreported results we find that the intraday 5-minute total number of transactions shows the well-known U-shaped pattern for each exchange.

[18] For Indonesia and Malaysia, the trading hours in Table 2 are for Monday to Thursday. Trading hours on Friday will be shorter. For Venezuela, trading hours will be shorter from April to October each year. For Israel, the trading hours are for the Telaviv 100 large stocks. Trading hours will be shorter for other stocks.

Trading hours vary significantly from exchange to exchange in our sample of 23 emerging markets. Thus, direct comparison of WPC for a fixed period of time (e.g., 30 minutes) across markets are problematic. Therefore, we calculate standardized WPC for given fractions of the trading day for further analysis. We divide total trading hours on each exchange into quintile groups. Each group accounts for 20% of the total trading hours. We calculate price contribution for each quintile interval for each stock. Specifically, the WPC for the j^{th} quintile interval is calculated as:

$$WPC_{i,j} = \sum_{t=1}^{T} \frac{|\, r_{i,t} \,|}{\sum_{t=1}^{T} |\, r_{i,t} \,|} \cdot \frac{\sum_{k \in j} r_{i,t,k}}{r_{i,t}} \qquad (2)$$

where $\sum_{k \in j} r_{i,t,k}$ denotes a return that occurred during the j^{th} quintile interval, and j=1, 2,.., 5.

Table 4 gives summary statistics about the cross-sectional sample of WPCs and the correlation of the explanatory variables. Panel A gives statistics for the cumulative and incremental quintile intervals. From Panel A it is clear that highest average WPC occurs in the first quintile of the day and the second largest occurs in the last quintile of the day. This is consistent with the U-shaped pattern of volume and volatility typically found in equity markets. In panel B we present the correlations of the stock-level explanatory variables. There is significant correlation across most of the variables.

Figure 1 summarizes the mean WPC across quintile intervals on 23 emerging market exchanges. The WPC from the earliest quintile interval has the highest value for 20 out of the 23 emerging markets, the exceptions being Hungary, Brazil, and Peru. For the three cases where the first quintile is not the largest, it is the second largest in two cases and the third largest in one case. Price discovery immediately after the market opens for trading is most important for the majority of the emerging markets in our sample. Generally speaking, the WPC seems to be highest for Asian and Eastern European countries during the first 20% of trading. In particular, the first 20% standardized WPC is as high as 0.468 for Taiwan 0.461 for South Korea, 0.456 for the Czech Republic, and 0.434 for the Poland. The WPC in last quintile period is the largest for two markets, the second largest for 15 countries, and the third largest in four markets. Thus the U-shaped pattern in WPC is a common feature across markets. As confirmed by unreported test

statistics (available from the authors), the intraday variation across 5-quintile groups is highly significant for 21 out of the 23 markets, with the exception of Peru and Venezuela.

Our finding of greater price discovery in the early part of the trading sessions is broadly consistent with the theoretical prediction of Admati and Pfleiderer (1988). Uninformed traders are more willing to trade in an environment when liquidity is abundant, such as in the periods immediately after the market opens. They are attracted by liquidity availability. Informed traders in possession of private information would like to disguise themselves. This is easiest to do when uninformed trades congregate during the early trading session. When more informed traders participate, the process of price discovery speeds up.

An unreported one-way ANOVA analysis is performed to test the null hypothesis that the price discovery in each quintile interval is equal across markets. This is done for each region separately as well as for across all markets. We reject, in all cases, the hypothesis that the average WPCs are equal across markets for all of the quintile periods.[19]

5. The Cross-Sectional Determinants of Price Discovery

This section examines some factors that determine the cross-sectional variation in price discovery in early trading for 23 emerging countries. We adopt the cross-sectional least squares regression approach from Huang (2002, Table X) who examines the relation between WPCs and share volume and other factors. The existing literature provides some evidence on the factors that might be related to institutional ownership and price discovery. For example, Falkenstein (1996) investigates the portfolio holdings of U.S. mutual funds and shows that mutual funds have a significant preference towards more liquid stocks with high visibility, more information, large market capitalization (with the exception of the small cap sector, which specializes in small firms), and low transaction costs. U.S. mutual funds are also averse to stocks with low idiosyncratic volatility.[20] Kang and Stulz (1997) also document that foreign investment holdings in Japan are biased towards large firms and low idiosyncratic risk, among other characteristics.

[19] We carry out the same analysis when the trading sessions are divided into quartile groups, where each quartile interval represents 25% of the total trading hours. All conclusions remain essentially the same as those from earlier sections.

[20] Falkenstein (1996) reports a positive coefficient on standard deviation but negative coefficients on variance, suggesting that mutual fund holdings are concave in standard deviation.

O'Brien and Bhushan (1990) find that analysts prefer to follow firms with low volatility and less competition from other analysts, while institutions tend to prefer firms with pre-existing analysts and with large size and risk.[21]

These early studies suggest that the following variables are potentially related to the process of price discovery, firm size, trading volume, bid-ask spread, return volatility, and number of analysts following the stock.[22] In addition to these factors, we also explore the role of domestic ownership, and additional three variables that measure the foreign investors' ability to invest in a stock. These three variables are the investability measure from the S&P's EMDB database; a dummy variable that represents the availability of depositary receipts and cross-listed shares traded on major international equity markets such as New York, London, and Tokyo; and direct foreign ownership as measured by percentage shares held by global institutional investors represented by open ended mutual funds and offshore funds.

We first examine the pair wise correlation from Panel B of Table 4 which reveals some interesting patterns. First, Panel B shows that domestic ownership has a low correlation of 0.04 with foreign ownership, a high 0.41 correlation with domestic fund ownership, a negative correlation of -0.08 with DR_CRO dummy, a high correlation of 0.19 with number of analysts following. Second, between investability and the DR_CRO dummy, investability and foreign ownership, and the DR_CRO dummy and foreign ownership are 0.15, 0.39, and 0.18, respectively. Third, foreign ownership also has high correlation of 0.21 and 0.33 with firm size and number of analysts following.

Now we proceed to the benchmark OLS regressions. Specifically, the cross-sectional regression for WPC from sample stock i, i=1, …, 1504, takes the following form:

[21] See also Schipper (1991) who provides a summary on analyst forecasts.

[22] We also construct the following two variables that do not yield significant estimates: (1) percentage of spread divided by the average of the bid and ask depths; (2) turnover as measured by the number of shares traded scaled by the total shares outstanding.

$$\text{WPC}_i = \delta_0 + \delta_1 \text{Firm Size}_i + \delta_2 \text{Trading Volume}_i + \delta_3 \text{Spread}_i + \delta_4 \text{Return Volatility}_i +$$

$$\delta_5 \text{Number of Analysts}_i + \delta_6 \text{Investability}_i + \delta_7 \text{DR\_CRO Dummy}_i + \delta_8 \text{US\_OPEN}_i +$$

$$\delta_9 \text{Domestic Ownership}_i + \delta_{10} \text{Foreign Ownership}_i +$$

$$\sum_{j=1}^{22} c_{ij} \text{Country Dummy}_{ij} + \sum_{k=1}^{9} d_{ik} \text{Industry Dummy}_{ik} + \varepsilon_i,$$

where in addition to the factors discussed earlier, we have also included 22 country dummies and 9 industry dummies. We have also included a dummy variable, US_OPEN, to capture the impact of overlapping trading with NYSE session.

5.1. Cross-Sectional Determinants of Price Discovery: Quintile Intervals

We implement the OLS regression for each of the five quintile WPCs and cumulative 20, 40, 60, and 80% WPCs. For brevity, we only report the OLS regressions when the dependent variables are the first (top panel) and last quintile WPCs (bottom panel) in Table 5. Other results will be briefly discussed.[23] Table 5 shows among various model specifications for the first 20% WPC in early trading, there is a significantly negative relation between percentage bid-ask spread, and the level of foreign ownership. The estimated coefficient on foreign ownership is 0.088 in model 6 with a t-statistic of 3.72. Higher trading costs hinder price discovery while more participating by foreign investors aid the stock price move faster to its equilibrium level. The number of analysts has a reliable positive slope of 0.005 which is significant at the 10% level. The intraday volatility has a positive and significant sign at the 10 level. This positive sign could reflect the co-movement of volatility and volume (Karpoff, 1987; Jones, Kaul, and Lipson, 1994), which are intensified in earlier sessions of trading. When we use open-to-close return standard deviation, the sign on volatility is negative (-0.008) and highly significant at 1% level (t-statistic = -2.01).

Domestic ownership, investibility, DR_CRO dummy, US_OPEN dummy, top3 and top5 domestic ownership, and domestic ownership concentration index are not significantly related to the level of price discovery. Firm size and trading volume are significantly only when they are

[23] The details of other regression are available upon request.

used alone in the model specification. They are subsumed by the percentage of bid-ask spread.

For many variables, the later quintiles have coefficients of the opposite sign of the initial periods. This has to be true since the WPCs sum to unity. For example,

$$WPC_{Last\ 20\%} = [1 - WPC_{First\ 20\%} - WPC_{Second\ 20\%} - WPC_{Third\ 20\%} - WPC_{Fourth\ 20\%}]$$

So a positive relation between one of the explanatory variables and the first four quintile WPCs, such as in the case of FOWN, implies a negative relation for the last 20% WPC.

The OLS regression for the last 20% WPC indicates exactly the opposite signs on SPD, NOA, and FOWN as the first 20% WPC. Foreign ownership has an estimated coefficient of -0.138 in model 6 with a t-statistic of -4.37. The sign on VOL now has the predicted positive sign and is highly significant. When we use the open-to-close return standard deviation, the estimated coefficient is 0.018 with a t-statistic of 3.26.

We now turn to the results when we regress cumulative 40, 60, and 80% WPCs and 2nd, 3rd, and 4th quintile WPCs on the same set of variables. For these regressions, we measure spread, volume, and volatility that match the trading hours of the corresponding intervals for the WPCs under consideration. The estimated coefficients (t-statistics) are 0.148 (4.40), 0.194 (4.87), and 0.160 (4.59) for the 40, 60, and 80% WPCs. For the 2nd, 3rd, and 4th quintile WPCs, the estimated coefficents (t-statistics) are 0.040 (1.67), 0.047(1.72), and -0.031 (-1.13), respectively. Overall we can conclude that the positive relation between FOWN and WPC appears to be robust throughout the course of a typical trading day. Nonetheless it is driven by the early trading immediately after the market opens.

5.2. How Do Foreign Ownership Accelerate Price Discovery?

The OLS evidence suggests that direct foreign ownership in the underlying stocks plays a more important role than either a measure of degree of openness (investability) or measure of indirect foreign accessibility (DR dummy). Higher foreign ownership leads to higher WPCs early in the trading day and seems to be associated with accelerated price discovery.

How do the positive associate with foreign ownership and price discovery arise? In this section we explore several alternative explanations for the effect. First, Brennan and Subrahmanyam (1995) report a strong positive association between number of analysts following each

stock and institutional ownership. At the same time, greater analyst coverage tends to reduce the adverse selection costs of transaction. This improves the intraday information environment of a stock.[24] We find a strong positive relation between FOWN and number of analysts as well, controlling for other factors such as SIZE, IWF, and DR_CRO dummy. But the association between price discovery and number of analysts following is in general significant around 10% and is stronger for the last 20% WPC than for the first 20% WPC (Table 6).

Second, Boehmer and Kelley (2009) suggest that when the benefit of information is increasing with the amount of investment and cost of information acquisition has a constant component or is independent of the precision of the information (Peress, 2004), institutional investors will focus on acquiring information on large ownership stocks, or concentrated ownership stocks. A significant presence of foreign investors, especially professional managed mutual and pension funds, simply reflect more efforts by these professional investors to acquire information.

Third, Holden and Subrahmanyam (1992) emphasize the role of competition among informed traders in possession of long-lived information. They show that such traders compete aggressively and cause most of their common private information be reflected in stock price rapidly. Boehmer and Kelly (2009) find empirical support for the competition effects in quarterly model. They report that ownership concentration in U.S. stocks reduces the efficiency of stock prices. Top-5 holdings have no effect on price efficiency. Instead, holdings by institutions outside the top-5 investors drive the price to be more efficient.

To test the concentration versus the competition explanations, we construct the following ownership variables from foreign investors, top-5, top-10, and top-35 percentage ownership, and other than top-5, top-10, and top-35 ownership, Herfindahl concentration index for foreign ownership. Table 6 reports the OLS regressions for various combinations of the independent variables. When the dependent variable is the first 20% WPC, the leading foreign investors (top-5, top-10, and top-35) are highly significant regardless of whether non-leading foreign investors (other than top-5, top-10, and top-35) are present or not. We examine the correlation between leading and non-leading foreign ownership. The correlation is 0.58 between top-5 and non-top-5 ownership, 0.57 between top10 and non-top-10, and 0.50 between top-35 and non-top-35. While

[24] Brennan, Jegadeesh, and Swaminathan (1993) stocks with more analysts following react faster to common information than stocks with fewer analysts following.

both leading and non-leading foreign investors help facilitate rapid price discovery, the role of leading foreign investors is important. The estimated coefficient on the Herfindahl index is 1.570 with a t-statistic of 3.82. Therefore for the first 20% WPC, the results provide strong support for the concentration story.

For the last 20% WPC, the leading foreign investors remain highly significant in the regressions when the non-leading foreign investors are not present. But the leading investors' role is subsumed by non-leading investors when we add the other than top-5, top-10, and top-35 foreign ownership. Therefore the role of non-leading foreign investors is more important toward the latter session of the trading day. Nonetheless, the Herfindahl concentration index has an estimated slope of -1.434 with a t-statistic of -2.48. Overall, the evidence is still in favor of the concentration explanation.[25, 26, 27, 28]

5.3. Rule of Law and Legal Origin

In recent years researchers have started to explore the role of law and its enforcement in finance. These include the relation between law and investor protection (LaPorta et al., 1998 and 2000), between law and size, breadth, and valuation of capital markets (1997), between law and dividend policy around the world (2000), and between law and corporate ownership (1999), and

[25] Boehmer and Kelley (2009) examine another explanation for the positive relation between institutional investors and price efficiency. They find that short-selling flow significantly increase price efficiency, consistent with Boehmer and Wu (2010). Nagel (2005) shows that institutionally owned shares are often available for borrowing by short sellers. Boehmer, Jones, and Zhang (2008) find that short-sellers are informed.

[26] Bris, Goetzmann, and Zhu (2004) examine whether short-sales restrictions affect the efficiency of 47 equity markets around the world. Among 23 emerging markets we study, nine countries do not allow short sell during our sample period. 14 countries allow short selling. However, short-selling is a common practice only Czech, Thailand, and South Africa. We cannot explore the relation between price discovery and level of short-selling due to limited practices and unavailability of comprehensive short-selling data.

[27] Boehmer and Kelley (2009) also explore the role of institutional trading in improving the efficiency of stock prices. The find that institutional-trading enhances price efficiency. However, none of the trading activity variables drives out the institutional holding on efficiency measures. Unfortunately proprietary trading data with allows to identify the identities of the institutions on a global basis is not available.

[28] Holdings or changes in holdings are poor proxy for institutional trading activity. First, Factset reports contain only end-of-quarter holdings reports, which reflect the eventual holding position that might be turnover many times during the reporting period. Second institutions like hedge funds hold significant short positions which need not be reported.

between law and government ownership of banks (2002). Djankov et al. (2003) examine the effective of courts as mechanisms of resolving disputes. The measurement of legal environment falls into the following catetories: (1) stability and social system including rule and order; (2) legal origin including the civil versus the common law system; (3) legal protection of investors' rights such as risk of contract repudiation by government, risk of expropriation, accounting standards; and (4) quality of legal system such as the enforcement of contracts, fairness and impartialness, honesty and uncorruption, consistency, confidence in the legal system, and efficiency of judicial system;

In general, these measurements are highly correlated in many cases. For example, investor protection index (anti-director rights in LaPorta et. al, 2000) and legal original has a highly negative correlation of -0.66. The correlation between rule of law and rupidiation risk is 0.67, whereas the correlation between rule and law and risk of expropriation is 0.73. We examine the role of these variables in our OLS regressions by adding these legal variables to Equation (3). Overall we find two variables are robust. The first is the rule of law measure constructed by the country-rating agency International Country Risk (ICR). The second is the legal origin, civil versus common law. We first obtain the rule of law measure from LaPorta's webpage. LaPorta's data is for the period between 1982 and 1995. We also obtain the measure for the most recent period from 2001 to 2006 from ICR. The empirical results from using the two set of measures yield essentially the same conclusion.

The last two columns of Panel A in Table 2 present the two measure 23 countries. The rule of law measure ranges from 0 to 10. Czech Republic has the highest score of 8.62 while Philippines has the lowest score of 2.73. The legal original takes the value of 1 when the country adopts the civil law and 0 when the country adopts the common law. There are six countries whose legal origin is common law, i.e., India, Malaysia, Pakistan, and Thailand, Israel, and South Africa. However, the number stocks add up 506, or 34% of the total number of 1,504. In Table 7, we summarize the regression results augmenting the original model with two legal variables. The rule of law measure has a stable estimate of 0.033 for the first 20% WPC with a t-statistic of 4.97 in model 1. The estimate for the last 20% WPC is -0.019 with a t-statistic of -3.69. Therefore we have documented that better rule of law and order tradition in the country facilitate early price discovery. The legal origin is not related to WPCs in a significant way but later we will show that it is an important determinant of the level of foreign ownership.

6. Instrumental Variables Estimates

6.1 First Stage Analysis

Foreign ownership variable is clearly endogenous. When an endogenous variable is used as one of the dependent variable, the estimated coefficient will be biased. To correct for potential biases in the OLS estimates due to the endogeneity of foreign ownership, we use instrumental variables (IV) estimators (two-stage least squares (2SLS)) to estimate the relationship, treating WPC and foreign ownership as endogenous variables.

Before performing the 2SLS analysis we wish to analyze the strength of the instruments we are using and test whether the exclusion restriction we use to identify the parameters seem to be valid. Table 8 reports the reduced form regressions in which the two endogenous variables are regressed on the variables presumed to be exogenous and provides diagnostics for model specification. Heteroskedasticity robust standard errors are reported in the table. We first test for the strength of the instruments. Panel A summarizes the analysis when the endogenous variable are the weighted price contribution (WPC) from the first period and foreign ownership (FOWN). Panel B summarize the analysis when the endogenous variable is the weighted price contribution (WPC) for the last period and foreign ownership (FOWN). The first stage R^2 and adjusted R^2 are from the regression of the endogenous variable on all exogenous variables, including the country and industry dummy variables. If the instruments are "weak," in the sense of having low correlation with the endogenous variable, then the IV coefficient estimate are biased. The first stage F-test is a test for the significance of the reduced form coefficient for the variable listed in the first column. The level of significance of the F-test is given in parentheses.

Stock and Yogo (2001) and Stock, Wright, and Yogo, (2002) argue that testing the null hypothesis that the instruments have zero explanatory power is not a good screen for issues associated with weak instruments. They propose looking at the bias in the 2SLS estimator relative to the bias in the OLS estimator. For example, one could test whether the 2SLS bias is less than x% of the OLS bias. These tests uses the same F-test, but with a different critical value. For a test of the 2SLS bias being less than 10% of the OLS bias they estimate the critical value to be 8.96 when testing the strength of one instrument. Using this criterion, the bid-ask spread, return volatility, and rule of law seems to be strong instrument for the WPCs. Firm size, Investability, the DR_CRO dummy, and number of analysts, and legal origin seem to be strong instruments for

foreign ownership.

6.2 Second Stage Analysis

The IV estimates are only identified if we exclude a sufficient number of exogenous variables from each equation. With one endogenous regressor in each equation, the parameters are identified by excluding one exogenous variable from each equation. If we exclude more than one exogenous variable, we have over-identifying restrictions that can be tested. Table 9 first shows 2SLS estimate of parameters the regression explaining WPCs in the earliest and latest quintile. The standard errors are robust to conditional heteroskedasticity. When the dependent variable is WPC and the predicted (instrumented) FOWN will be one of the independent variables in the second stage regression. Over-identifying restriction test statistic of 4.79 (Wooldridge (1995)) does not reject the exclusion restrictions. The coefficient on the predicted (instrumented) value of FOWN are significant, being 0.161 (2.77) and -0.166 (-2.88), respectively. The 2SLS estimates confirm the results from the OLS regressions.

When the dependent variable is FOWN and the predicted (instrumented) WPC will be one of the independent variables in the second stage regression. Over-identifying restriction test does not reject the exclusion restrictions either. The coefficient on the predicted (instrumented) value of WPC are not significant, being 0.043 (0.83) and -0.038 (-0.83), respectively. The important determinants for FOWN are SIZE, IWF, DR_CRO, NOA, and legal origin. Notice legal origin has a negative estimate of -0.037 (-3.14) and -0.038 (-3.33), respectively, from the first and last 20% quintile regressions. In our sample of 1,504 stocks, foreign investors (mainly US mutual and pension funds) invest a large percentage in English or common-law countries.

Table 9 also reports two tests of the exogeneity of the endogenous regressor (FOWN in the regressions with WPC as the dependent variable and WPC in the regressions with FOWN as the dependent variable). Exogeneity test 1 is the Wooldridge (1995) score test, which is robust version of the Durbin test. Exogeneity test 2 is a robust version of the Wu-Hausman test. The tests indicate that endogeneity may not be as large an issue as we thought. The exogeneity of FOWN is never rejected for the earliest quintile period of the day and for the last quintile of the day. The results suggest that it is probably safe to rely on the OLS results of Table 7.

To formally test whether the estimates from OLS and 2SLS are the same, we carry out Hausman specification tests for the instrumented FOWN, instrumented WPC, rule of law, legal

origin, and test of the economic variables. For example, the test statistic (p-value) is 0.99 (0.32) for the null hypothesis that the OLS estimate for FOWN and 2SLS estimate for instrumented FOWN are the same. Therefore we cannot reject the null hypothesis that the estimates from OLS and 2SLS are the same. Overall, all Hausman tests suggest that there is no significant difference between the OLS results and 2SLS results.

One important concern is that foreign ownership and the level of price discovery is likely to jointly determined. The issue is the direction of the causality. Do foreign investors help enhance price discovery or do foreign investors prefer those stocks that have low trading costs such as bid-ask spread and reside in countries where rule of law condition is better, and therefore tend to tend to reach equilibrium price earlier? To address this concern, we carry out 3SLS regression in Table 9. In a 3SLS system, the equation for WPC and FOWN are estimated simultaneously. Table 9 shows that the 3SLS corroborate the findings from 2SLS. The causality direction is firmly established from FOWN to WPC, i.e., the participation of foreign investors facilitate price discovery.

7. Sensitivity of OLS Estimates to Confounding Variables

In any regression analysis there is always the possibility that the explanatory power of an independent variable is due to an omitted variable that is a confounding variable (CV), that is a variable correlated with both the dependent and independent variables. Economic theory should suggest which variables are likely to be confounding variables and they should be included in the analysis.

In our case, suppose Z is define as the set of 41 exogenous variables in the following way:

$$\begin{aligned} Z = [&Intercept, Firm\ Size, Trading\ Volume, Spread, \text{Re}turn\ Volatility, \\ &Investibility, DR\ Dummy, Number\ of\ Analysts, Rule\ of\ Law, Legal\ Origin, \\ &22\ Country\ Dummies,\ 9\ Industry\ Dummies] \end{aligned} \quad (4)$$

Then Equation (3) can be simplified to

$$WPC_i = \delta_0 + \Delta \bullet Z_i + \delta_{10} FOWN + \alpha CV_i + \varepsilon_i, \quad (5)$$

where Δ is the set of parameters in Equation (3) excluding δ_0 and δ_{10}, CV denotes the confounding variable. Similar to the result in the first row of Table 7, the estimate for $\hat{\delta}_{10}$ equals 0.109

with a t-statistic of 3.79 for the first quintile WPC and the estimate for $\hat{\delta}_{10}$ equals -0.164 with a t-statistic of -4.59 for the last quintile WPC.[29]

Larcker and Rusticus (2010) suggest assessing the sensitivity of the OLS estimates to unobserved correlated variables using the methods of Frank (2000). Any bias in the OLS estimates due to a confounding omitted variable are related to the correlation between the omitted variable and both the independent and dependent variables. Frank (2000) derives the minimum correlations necessary to turn a statistically significant OLS coefficient into an insignificant result, which he calls the Impact Threshold for a Confounding Variable (ITCV).

We wish to determine if it is likely that the significant coefficient on foreign ownership in earlier tables could be rendered insignificant by a confounding variable. The ITCV is the minimum absolute value of the product of (i) the partial correlation between WPC and confounding variable, controlling for the other instruments (Z), $r_{WPC \cdot CV|Z}$, and the partial correlation between FOWN and the confounding variable $r_{FOWN \cdot CV|Z}$, that drives the t-statistic on FOWN to borderline significance. Table 10 shows the value of the ITCV = $r_{WPC \cdot CV|Z} \times r_{FOWN \cdot CV|Z}$ for FOWN to be 0.0168 (-0.0392) for the earliest (latest) quintile in panel A (B). Any confounding variable having the product of partial correlations greater, in absolute value, than ITCV would overturn the significance of FOWN in earlier tables. This implies minimum absolute partial correlations with the confounding variable of 0.119 and 0.141 for WPC and FOWN, respectively for the earliest quintile and 0.178 and 0.220 for the latest quintile, when the critical t-statistic is set to be 1.96 in absolute value (5% significance). The requirement on the partial correlations will be more demanding at 0.135 and 0.159 for the first quintile and 0.187 and 0.231 for the last quintile, respectively, if the confounding variable is going to reduce the t-statistic on $\hat{\delta}_8$ to be 1.65 (10% significance) in absolute value.

To get a sense for whether the ITCV is likely to be breached by some confounding variable, we calculate the product of partial correlations for all of the nine exogenous variables used

[29] We can also examine the impact of a confounding variable when FOWN is regressed on WPC and Z instead. $FOWN_i = \lambda_0 + \Lambda \bullet Z_i + \lambda_{10} WPC_i + \beta CV_i + \varepsilon_i$. The above analysis will generate the same ITCV results. This is because the calculation of $R^2_{WPC \bullet Z}$, $R^2_{FOWN \bullet Z}$, and $r_{WPC \bullet FOWN}|_Z$ does not need to specify the direction of the regression, i.e., WPC on (FOWN, Z) or FOWN on (WPC, Z). The table also reports the estimated coefficients and t-statistics when FOWN is regressed on (WPC, Z).

in Table 8. The impact of these variables ($PC_1 \times PC_2$) is always much smaller that the ITCV, so we conclude that no confounding variable, similar in nature to the variables used here, would overturn the significance of foreign ownership in the OLS results in earlier tables. This does not prove that no such confounding variable exists. However, the demanding requirements on its high partial correlations with FOWN and WPC will be difficult to meet given the partial correlations we obtain from existing variables from numerous studies of market microstructure and determinants of equity ownership including foreign ownership. In Panel A of Table 10 for example, when CV is set to be spread, the partial correlation $PC_1 = r_{WPC \bullet CV}|_{Z'}$ is -0.2623. When CV is set to be number of analysts, the partial correlation $PC_2 = r_{FOWN \bullet CV}|_{Z'}$ is 0.1844. The product of -0.2623 with 0.1844 is equal to -0.0484, larger than the threshold ITCV of 0.0168 and 0.0215 in absolute value. Therefore if we have a *single* variable that is as strong as spread in predicting WPC and at the same as strong as number of analysts in predicting FOWN, then the significance of $\hat{\delta}_{10}$ from OLS applied to Equation (5) will be overturned.

Due to the lack of evidence that such a confounding variable is immediately in sight from the existing literature that would overturn our inference from earlier tables, we conclude that foreign ownership is significantly related to price discovery early in the trading day. Thus, foreign ownership seems to lead to more timely and efficient asset prices.

8. Conclusions

The primary objective of this paper is two fold. First we examine the role of foreign investors in the process of price discovery in emerging markets. To this end, we assemble trade and quote data for a sample of 1,504 stocks from 23 emerging markets over an period of eight months, from 2006 to 2007. We construct weighted price contributions for each stock and document significant intraday and cross-sectional variations that are consistent with both the theoretical prediction and empirical results of market microstructure studies. Moreover, we find a reliably significant positive impact of direct foreign ownership on the cross-sectional determinants of early price discovery in emerging markets, after controlling for other factors such as firm size, trading volume, bid-ask spread, and return volatility, and number of analysts following.

We test several alternative explanations for the positive association between foreign ownership and more speedy price discovery and find strong support for the information acquisition cost

model of Boehmer and Kelly (2009).

There is some debate about the role of foreign investors in emerging markets. Choe, Kho, and Stulz (1999) offer direct evidence regarding the role of foreign investors during the 1997 crisis. They conclude that, in fact, large sale transactions initiated by foreign investors help the market adjust quickly to equilibrium levels without causing negative abnormal returns. Our paper adds to the literature by documenting the greater price discovery which is affiliated with a more significant presence of foreign investors in home markets. Our results are consistent with those of Choe, Kho, and Stulz (1999) in that the presence of foreign investors is related to faster adjustment of prices to information.

Our second objective is to explore the relation between legal environment and the speediness of price discovery. We hope to answer the question of whether a better legal environment facilitate price discovery on a daily basis. We examine a host of variables used in earlier research that mainly focus on legal approach to corporate finance. Notably, we find that rule of law measure plays an important role in the process of price discovery, after controlling for other factors including foreign ownership. Our finding establishes a positive link between the quality of legal environment and efficiency of financial markets, where the latter is important for the ultimate goal of economic development (King and Levine, 1993; Levine and Zervos, 1997).

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Table 1 Sample Stocks

The table lists the distribution of 1,504 sample stocks from 23 emerging markets in the S&P Emerging Market Database (EMDB). We exclude infrequently traded stocks, stocks with a significant portion of large percent quoted spreads, and stocks experiencing splits or changes in minimum trading unit during the sample period (August 29, 2006 to May 2, 2007).

	All Stocks	Infrequently Traded	High Frequency of Large Quoted Spread	Stock Split or Minimum Trading Unit Change	Final Sample
Asia					
China	220	0	0	0	220
India	154	0	0	1	153
Indonesia	35	1	0	0	34
South Korea	259	0	0	2	257
Malaysia	90	0	0	0	90
Pakistan	45	2	0	0	43
Philippines	28	0	0	0	28
Taiwan	137	0	0	3	134
Thailand	74	6	0	0	68
Eastern Europe					
Czech Rep.	6	0	0	0	6
Hungary	11	0	0	0	11
Poland	32	0	0	0	32
Russia	36	29	0	0	7
Latin America					
Argentina	17	0	0	1	16
Brazil	88	2	1	4	81
Chile	53	14	0	0	39
Mexico	46	5	2	0	39
Peru	25	7	0	0	18
Venezuela	13	10	1	0	2
Other Countries					
Egypt	27	0	1	0	26
Israel	50	0	0	0	50
South Africa	107	5	0	0	102
Turkey	48	0	0	0	48
All	1601	81	5	11	1504

Table 2 Average Firm Characteristics by Market

Panel A of this table provides summary statistics for the 1,504 stocks from 23 emerging markets in the final sample. The numbers reported are the cross-sectional median from each country for firm size, average daily stock price, average daily trading volume in million, daily return volatility, quoted spread in percentage, and number of analysts following each stock. Number of analysts following each stock is from the I/B/E/S dataset. Cross-sectional means are reported for investability index from the EMDB dataset. Total number of DRs are reported for each country. DR Dummy is from the Bank of New York webpage. Cross-listed firms are from Factset. A country is assigned value of 1 when its trading hour overlaps with U.S. (NYSE) trading hours. Rule of Law and legal origin are taken from LaPorta (1998). A civil law country is assigned a value of 1 while a common law country is assigned a value of 0. Panel B reports the means of the number of domestic investors, domestic ownership in percentage, top-3 and top-5 domestic ownership, domestic fund ownership (DOM_FUND), and domestic ownership concentration (Herfindahl) index. Domestic ownership is from Osiris database. Panel B reports the means of foreign investors, top-5, top-10, top-35 foreign ownership, and foreign ownership concentration (Herfindahl) index. Foreign Ownership is the fraction of shares held by non-local investors constructed from the FactSet's Lionshare database. Number of analysts following each stock is from the I/B/E/S dataset.

Panel A Firm, Trading, and Legal Characteristics

	Firm Size (Million US$)	Average Daily Stock Price (US$)	Average Daily Trading Volume (Million US$)	Daily Return Volatility(%)	Quoted Spread (%)	Investability	DR and Cross-Listed Dummy	Number of Analysts	US Market Open for Trading	Rule of Law	Legal Origin
Asia											
China	674	0.9	11.40	3.14	0.21	0.09	75	1	0	6.03	1
India	1463	9.0	1.23	2.33	0.17	0.28	43	0	0	4.17	0
Indonesia	1707	0.4	3.85	2.31	0.84	0.38	4	11	0	3.98	1
South Korea	763	28.8	4.13	2.12	0.28	0.53	31	6	0	5.35	1
Malaysia	855	1.4	1.61	2.24	0.74	0.44	7	2	0	6.78	0
Pakistan	368	1.4	1.34	2.05	0.30	0.05	5	0	0	3.03	0
Philippines	983	1.0	1.27	2.45	1.33	0.27	6	4	0	2.73	1
Taiwan	1334	0.8	7.90	1.85	0.22	0.80	50	5	0	8.52	1
Thailand	626	0.5	1.35	2.47	0.78	0.32	2	9	0	6.25	0
Eastern Europe											
Czech Rep.	4198	52.0	19.81	1.53	0.48	0.39	3	8	1	8.62	1
Hungary	795	32.6	1.98	1.81	0.34	0.39	5	4	1	8.48	1
Poland	1705	25.8	1.77	2.25	0.53	1.00	9	3	1	7.68	1
Russia	43756	82.3	5.59	2.28	0.66	0.41	4	11	1	5.21	1
Latin America											
Argentina	1129	1.4	0.46	1.36	0.68	0.42	9	1	1	5.35	1
Brazil	2496	12.7	8.13	2.91	0.71	0.49	43	4	1	6.32	1
Chile	1630	1.7	2.16	1.45	0.89	0.47	17	1	1	7.02	1
Mexico	3133	3.6	3.09	1.90	0.92	0.47	24	2	1	5.35	1

Peru	705	1.9	0.39	2.10	1.82	0.36	5	0	1	2.50	1
Venezuela	945	1.3	0.22	4.40	2.68	0.21	2	0	1	6.37	1
Other Countries											
Egypt	557	9.9	1.28	2.25	0.87	0.38	7	2	0	4.17	1
Israel	907	12.4	5.73	1.61	0.43	0.45	15	0	1	4.82	0
South Africa	1119	4.4	1.75	1.97	0.82	0.69	40	0	1	4.42	0
Turkey	1041	0.0	0.01	2.76	0.69	0.33	16	7	0	5.18	1

Panel B: Domestic and Foreign Ownership

	Major Domestic Investors						Major Foreign Investors					
	Number of Investors	All	Top-3	Top-5	DOM_ FUND	Concentration Index	Number of Investors	All	Top-5	Top-10	Top-35	Concentration Index
Asia												
China	2	3.93	3.54	3.81	1.25	0.0097	2	2.78	2.53	2.68	2.78	0.0018
India	5	11.55	10.45	11.11	1.37	0.0201	28	7.09	5.35	6.23	6.96	0.0015
Indonesia	1	13.68	13.68	13.68	0.00	0.0741	55	8.81	5.29	6.80	8.45	0.0012
South Korea	7	26.24	22.63	25.20	3.58	0.0496	36	8.51	6.12	7.16	8.22	0.0026
Malaysia	9	25.38	20.90	22.59	7.68	0.0643	29	5.99	4.03	4.91	5.78	0.0012
Pakistan	3	8.01	7.46	7.69	2.47	0.0296	4	0.79	0.76	0.79	0.79	0.0001
Philippines	3	41.77	39.31	41.53	9.26	0.1314	35	7.04	4.75	5.84	6.88	0.0013
Taiwan	8	25.39	18.78	22.12	2.29	0.0319	53	8.15	5.19	6.31	7.70	0.0016
Thailand	3	10.95	10.64	10.87	3.28	0.0356	23	5.33	4.25	4.87	5.28	0.0011
Eastern Europe												
Czech Rep.	3	1.08	1.07	1.08	0.41	0.0002	106	12.53	5.66	7.39	10.96	0.0019
Hungary	4	16.06	15.97	16.06	0.37	0.0454	73	15.76	9.95	11.86	14.40	0.0041
Poland	4	17.63	16.64	17.44	2.34	0.0575	49	7.32	4.65	5.61	6.92	0.0014
Russia	1	0.25	0.25	0.25	0.00	0.0001	64	5.06	2.24	3.13	4.67	0.0005
Latin America												
Argentina	2	14.96	14.96	14.96	0.21	0.0677	6	0.41	0.40	0.41	0.41	0.0001
Brazil	2	9.68	9.67	9.68	1.97	0.0467	37	6.72	4.67	5.77	6.62	0.0015
Chile	2	15.24	13.74	14.30	3.17	0.0568	11	1.21	1.03	1.17	1.21	0.0001
Mexico	2	3.52	3.52	3.52	1.48	0.0192	45	8.70	5.13	6.55	8.35	0.0019
Peru	2	27.00	26.28	27.00	2.06	0.1119	2	0.39	0.39	0.39	0.39	0.0001
Venezuela	1	21.37	21.37	21.37	0.00	0.0913	3	2.84	2.84	2.84	2.84	0.0015
Other Countries												
Egypt	2	10.21	10.21	10.21	1.30	0.0430	11	2.02	1.71	1.88	2.02	0.0006
Israel	1	7.92	7.67	7.92	0.03	0.0251	24	6.56	3.63	4.69	6.20	0.0018
South Africa	6	12.76	11.28	12.18	3.44	0.0273	30	4.97	3.44	4.10	4.83	0.0009
Turkey	2	38.51	38.44	38.51	2.44	0.1935	50	10.50	6.46	8.24	10.17	0.0019

Table 3 Continuous Limit Order Trading Hours of 23 Emerging Markets Exchanges

This table provides a summary of continuous limit order book trading sessions in local time and total trading hours for the 23 emerging markets in the sample. The data source is the Handbook of World Stock, Derivative & Commodity Exchanges (2005). The trading sessions are confirmed by a plot of the intraday patterns of daily number of transactions that took place during the sample period (August 29, 2006 to May 2, 2007). The last column of the table lists the length of overlapping trading hours with NYSE session in each market. Pre-open and after hour sessions are excluded.

	Trading Sessions		Trading Hours	Overlapping with NYSE Trading Hours
Asia				
China	9:30-11:30	13:00-15:00	4 hours	
India		9:55-15:30	5.5 hours	
Indonesia	9:30-12:00	13:30-16:00	5 hours	
South Korea		9:00-15:00	6 hours	
Malaysia	9:00-12:30	14:30-17:00	6 hours	
Pakistan		9:45-14:15	4.5 hours	
Philippines		9:30-12:00	2.5 hours	
Taiwan		9:00-13:30	4.5 hours	
Thailand	10:00-12:30	14:30:16:30	4.5 hours	
Eastern Europe				
Czech Rep.		9:30-16:00	6.5 hours	0.5 hours
Hungary		9:05-16:30	7.5 hours	1 hours
Poland		10:00-16:20	6.33 hours	0.83 hours
Russia		10:30-18:45	8.25 hours	1.25 hours
Latin America				
Argentina		11:00-17:00	6 hours	5.5 hours
Brazil		11:00-18:00	7 hours	6.5 hours
Chile		9:30-17:30	8 hours	6.5 hours
Mexico		8:30-15:00	6.5 hours	6.5 hours
Peru		9:30-13:30	4 hours	4 hours
Venezuela		10:30-14:45	4.25 hours	4.25 hours
Other Countries				
Egypt		11:30-15:30	4 hours	
Israel		9:45-16:45	7 hours	0.25 hours
South Africa		9:00-16:50	7.83 hours	0.33 hours
Turkey	9:30-12:00	14:00:16:30	5 hours	

Table 4 Summary Statistics for WPCs and Simple Pair-Wise Correlations between Domestic and Foreign Ownership and Other Variables

For each country, the intraday trading hours are divided into quintile groups with each group representing 20% of the entire trading session. Panel A of the table reports the summary statistics on weighted price contributions (WPCs) from a pooled cross-section of 1,504 stocks in 23 emerging markets. The summary statistics include the mean, median, 5 percentile, 95 percentile, minimum, maximum, and standard deviation. The summary statistics are calculated for cumulative 20, 40, 60, and 80% WPCs and for incremental WPCs within each quintile group. The WPCs are calculated following the method in Barclay and Warner (1993). Panel B reports the pair-wise simple correlations between domestic ownership (DOM), domestic fund ownership (DOM_FUND), foreign ownership (FOWN), other seven economic variables including firm size (SIZE) , trading volume in US$ (VOM), percentage bid-ask spread (SPD), percentage return volatility, or percentage return standard deviation (VOL), investable weight factor (IWF), DR or cross-listed dummy (DR_CRO), and number of analysts following each stock (NOA), two legal variables (rule of law and legal origin), and one variable (US_OPEN) representing overlapping with U.S. trading hours. Trading volume, spread, return volatility, and US_OPEN dummy are measured for the entire trading day from open to close. * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Panel A: Summary Statistics for WPCs

	Cum. 20%	Cum. 40%	Cum. 60%	Cum. 80%
Mean	0.365	0.529	0.667	0.799
Median	0.371	0.531	0.676	0.818
Minimum	0.003	0.030	-1.873	-0.099
Maximum	0.931	0.844	1.440	1.123
Standard Deviation	0.110	0.118	0.131	0.107

	First 20%	Second 20%	Third 20%	Fourth 20%	Last 20%
Mean	0.365	0.164	0.138	0.132	0.201
Median	0.371	0.164	0.137	0.125	0.182
Minimum	0.003	-0.417	-1.932	-1.027	-0.123
Maximum	0.931	0.715	0.872	2.304	1.099
Standard Deviation	0.110	0.066	0.088	0.096	0.107

Panel B: Simple Pair-Wise Correlations

Variables	DOM	DOM_ FUND	FOWN	SIZE	VOM	SPD	VOL	IWF	DR_CRO	NOA	US_ OPEN	Rule of Law
(1) DOM_FUND	0.41**											
(2) FOWN	0.04	0.03										
(3) SIZE	0.07**	-0.01	0.21**									
(4) VOM	-0.10**	-0.01	0.09**	0.50**								
(5) SPD	0.01	0.02	-0.12**	-0.22**	-0.48**							
(6) VOL	-0.08**	0.01	-0.09**	-0.15**	0.07**	0.01						
(7) IWF	0.08**	0.04*	0.39**	0.14**	0.15**	-0.02	-0.25**					
(8) DR_CRO	-0.08**	-0.06**	0.18**	0.22**	0.14**	-0.04	0.01	0.15**				
(9) NOA	0.19**	0.06**	0.33**	0.32**	0.18**	-0.13**	-0.09**	0.21**	0.06**			
(10) US_OPEN	-0.12**	-0.05*	-0.03	0.17**	0.05*	0.39**	-0.12**	0.24**	0.21**	-0.15**		
(11) Rule of Law	0.08**	-0.04	0.05**	-0.09**	0.10**	-0.43**	-0.12**	-0.01	-0.08**	0.08**	-0.45**	
(12) Legal Origin	0.09**	-0.05*	0.05*	0.03	0.14**	-0.05*	0.10**	0.07**	0.09**	0.29**	-0.05**	0.32**

Table 5 The Cross-Sectional Determinants of Price Discovery in Emerging Markets

The first part of this table summarizes OLS regressions to explain the first 20% WPCs over the intraday period. The second part summarizes OLS regressions for the last 20% WPCs. The WPCs are regressed on alternative combinations of domestic ownership (DOM), top-3 and top-5 domestic ownerships (DTOP3 and DTOP5), domestic ownership concentration index (DHX), foreign ownership (FOWN), seven economic variables, one variable representing overlapping with U.S. trading hours (US_OPEN), 22 country dummies, and nine industry dummies. The seven economic variables include SIZE, VOM, SPD, VOL, IWF, DR_CRO, and NOA. VOM, SPD, VOL, and US_OPEN are measured over the relevant trading intervals that correspond to the first and last 20% WPCs. Robust t-statistics are in parentheses below the estimates. * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Model	Intercept	SIZE	VOM	SPD	VOL	IWF	DR_ CRO	NOA	US_ OPEN	DOM	DTOP3	DTOP5	DHX	FOWN	CDUM, IDUM	R^2, Obs
	The dependent variable is the first 20% WPC															
1	0.246	0.006								-0.008				0.121	Yes	0.463
	(7.86)**	(2.91)**								(-0.65)				(4.76)**		1504
2	0.306		0.007							-0.007				0.116	Yes	0.467
	(10.78)**		(4.32)**							(-0.63)				(4.75)**		1504
3	0.333	0.001	-0.003	-0.039						-0.009				0.101	Yes	0.501
	(10.23)**	(0.48)	(-1.38)	(-7.33)**						(-0.79)				(4.05)**		1504
4	0.329			-0.036	0.023					-0.007				0.102	Yes	0.526
	(12.21)**			(-8.47)**	(1.79)*					(-0.69)				(4.31)**		1504
5	0.325			-0.036	0.023	-0.008	0.002		0.007	-0.008				0.110	Yes	0.526
	(9.64)**			(-8.49)**	(1.79)*	(-0.87)	(0.40)		(0.19)	(-0.75)				(4.10)**		1504
6	0.326			-0.035	0.023			0.005		-0.009				0.088	Yes	0.527
	(11.82)**			(-8.01)**	(1.78)*			(1.67)*		(-0.87)				(3.72)**		1504
7	0.326			-0.035	0.023			0.005			-0.011			0.089	Yes	0.527
	(11.82)**			(-8.01)**	(1.78)*			(1.67)*			(-0.89)			(3.73)**		1504
8	0.326			-0.035	0.023			0.005				-0.011		0.088	Yes	0.527
	(11.82)**			(-8.01)**	(1.78)*			(1.68)*				(-0.98)		(3.71)**		1504
9	0.325			-0.035	0.023			0.005					-0.011	0.089	Yes	0.527
	(11.84)**			(-7.99)**	(1.78)*			(1.60)					(-0.44)	(3.77)**		1504
	The dependent variable is the last 20% WPC															
1	0.269	-0.005								-0.003				-0.172	Yes	0.442
	(12.23)**	(-2.74)**								(-0.25)				(-5.42)**		1504
2	0.228		-0.003							-0.004				-0.176	Yes	0.440
	(11.87)**		(-1.80)*							(-0.36)				(-5.74)**		1504
3	0.274	-0.007	0.006	0.029						-0.002				-0.184	Yes	0.454
	(9.12)**	(-2.37)**	(2.05)**	(2.48)**						(-0.13)				(-5.36)**		1504
4	0.194			0.022	0.031					0.002				-0.151	Yes	0.575
	(9.95)**			(2.48)**	(9.38)**					(0.15)				(-4.92)**		1504
5	0.147			0.022	0.031	0.006	0.001		0.044	0.002				-0.161	Yes	0.575
	(5.28)**			(2.51)**	(9.34)**	(0.69)	(0.32)		(1.46)	(0.20)				(-4.81)**		1504
6	0.197			0.021	0.031			-0.005		0.003				-0.138	Yes	0.576
	(10.07)**			(2.31)**	(9.36)**			(-1.81)*		(0.31)				(-4.37)**		1504
7	0.197			0.021	0.031			-0.005			0.005			-0.138	Yes	0.576
	(10.05)**			(2.31)**	(9.36)**			(-1.82)*			(0.36)			(-4.38)**		1504
8	0.197			0.021	0.031			-0.005				0.004		-0.137	Yes	0.576
	(10.06)**			(2.31)**	(9.36)**			(-1.81)*				(0.37)		(-4.37)**		1504

9	0.197 (10.05)**		0.020 (2.30)**	0.031 (9.37)**	-0.005 (-1.80)*		0.015 (0.57)	-0.137 (-4.36)**	Yes	0.576 1504

Table 6 Analyst Coverage, Foreign Ownership Concentration, and Price Discovery in Emerging Markets

The first part of this table summarizes OLS regressions to explain the first 20% WPCs over the intraday period. The second part summarizes OLS regressions for the last 20% WPCs. The WPCs are regressed alternative combinations of number analysts (NOA), domestic fund ownership (DOM_FUND), foreign ownership (FOWN), top-5, top-10, and top-35 foreign ownership (FTOP5, FTOP10, and FTOP35), other than top-5, top-10, and top-35 foreign ownership, foreign ownership concentration index (FHX), percentage spread (SPD), percentage return volatility (VOL), 22 country dummies, and nine industry dummies. Robust t-statistics are in parentheses below the estimates. SPD and VOL are measured over the relevant trading intervals that correspond to the first and last 20% WPCs. * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Model	Intercept	NOA	DOM_ FUND	FOWN	FTOP5	FTOP10	FTOP35	Other than FTOP5	Other than FTOP10	Other than FTOP35	FHX	SPD, VOL, CDUM, IDUM,	R^2	Obs
	The dependent variable is the first 20% WPC													
1	0.325	0.004	0.007	0.090								Yes	0.527	1504
	(11.85)**	(1.56)	(0.24)	(3.81)**										
2	0.325	0.005	0.004		0.132							Yes	0.527	1504
	(11.92)**	(1.70)*	(0.16)		(3.67)**									
3	0.326	0.005	0.010					0.142				Yes	0.525	1504
	(11.87)**	(1.80)*	(0.34)					(2.85)**						
4	0.325	0.005	0.006		0.109			0.061				Yes	0.527	1504
	(11.86)**	(1.58)	(0.21)		(2.61)**			(1.02)						
5	0.324	0.005	0.005			0.117						Yes	0.527	1504
	(11.89)**	(1.62)	(0.18)			(3.80)**								
6	0.326	0.006	0.010						0.161			Yes	0.525	1504
	(11.91)**	(1.93)*	(0.34)						(2.24)**					
7	0.324	0.005	0.005			0.113			0.019			Yes	0.527	1504
	(11.87)**	(1.59)	(0.19)			(3.10)**			(0.21)					
8	0.324	0.005	0.006				0.096					Yes	0.527	1504
	(11.86)**	(1.58)	(0.23)				(3.81)**							
9	0.327	0.005	0.009							0.381		Yes	0.524	1504
	(11.97)**	(2.09)**	(0.31)							(1.39)				
10	0.324	0.005	0.006				0.099			-0.084		Yes	0.527	1504
	(11.87)**	(1.59)	(0.22)				(3.41)**			(-0.28)				
11	0.326	0.006	0.005								1.570	Yes	0.526	1504
	(12.00)**	(2.03)**	(0.16)								(3.82)**			

Model	Intercept	NOA	DOM_ FUND	FOWN	FTOP5	FTOP10	FTOP35	Other than FTOP5	Other than FTOP10	Other than FTOP35	FHX	SPD, VOL, CDUM, IDUM,	R^2	Obs
	The dependent variable is the last 20% WPC													
1	0.198	-0.005	0.020	-0.139								Yes	0.576	1504
	(10.14)**	(-1.80)*	(0.75)	(-4.45)**										
2	0.198	-0.006	0.022		-0.130							Yes	0.571	1504
	(10.10)**	(-2.44)**	(0.82)		(-2.86)**									
3	0.196	-0.004	0.014					-0.361				Yes	0.580	1504
	(10.04)**	(-1.60)	(0.50)					(-6.86)**						
4	0.196	-0.004	0.014		0.005			-0.365				Yes	0.580	1504
	(9.99)**	(-1.61)	(0.49)		(0.12)			(-6.47)**						
5	0.198	-0.006	0.022			-0.136						Yes	0.573	1504
	(10.14)**	(-2.21)**	(0.81)			(-3.35)**								
6	0.196	-0.004	0.013						-0.504			Yes	0.579	1504
	(9.95)**	(-1.74)*	(0.48)						(-7.47)**					
7	0.196	-0.004	0.015			-0.039			-0.454			Yes	0.580	1504
	(9.94)**	(-1.62)	(0.53)			(-0.88)			(-5.41)**					
8	0.198	-0.005	0.021				-0.139					Yes	0.575	1504
	(10.14)**	(-1.89)*	(0.76)				(-4.16)**							
9	0.195	-0.006	0.015							-1.453		Yes	0.576	1504
	(9.90)**	(-2.17)**	(0.54)							(-5.31)**				
10	0.196	-0.004	0.017				-0.094			-1.008		Yes	0.578	1504
	(9.98)**	(-1.62)	(0.63)				(-2.69)**			(-3.59)**				
11	0.197	-0.007	0.022								-1.434	Yes	0.570	1504
	(10.10)**	(-2.85)**	(0.81)								(-2.48)**			

Table 7 Rule of Law, Legal Origin, and Price Discovery in Emerging Markets

The first part of this table summarizes OLS regressions to explain the first 20% WPCs over the intraday period. The second part summarizes OLS regressions for the last 20% WPCs. The WPCs are regressed alternative combinations of number analysts (NOA), domestic fund ownership (DOM_FUND), foreign ownership (FOWN), , foreign ownership concentration index (FHX), and rule of law, legal origin, controlling for, percentage spread (SPD), percentage return volatility (VOL), 22 country dummies, and nine industry dummies. Robust t-statistics are in parentheses below the estimates. SPD and VOL are measured over the relevant trading intervals that correspond to the first and last 20% WPCs. * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Model	Intercept	NOA	DOM_ FUND	FOWN	FHX	Rule of Law	Legal Origin	SPD, VOL, CDUM, IDUM	R^2	Obs
	The dependent variable is the first 20% WPC									
1	0.222 (7.18)**	0.004 (1.56)	0.007 (0.24)	0.090 (3.81)**		0.033 (4.97)**	-0.029 (-1.18)	Yes	0.527	1504
2	0.224 (7.29)**	0.006 (2.03)**	0.005 (0.16)		1.569 (3.82)**	0.033 (5.09)**	-0.032 (-1.29)	Yes	0.526	1504
	The dependent variable is the last 20% WPC									
1	0.280 (12.11)**	-0.005 (-1.80)*	0.020 (0.75)	-0.139 (-4.45)**		-0.019 (-3.69)**	-0.008 (-0.39)	Yes	0.576	1504
2	0.279 (11.99)**	-0.007 (-2.85)**	0.022 (0.81)		-1.434 (-2.48)**	-0.020 (-3.95)**	-0.003 (-0.15)	Yes	0.570	1504

Table 8 Diagnosis of Model Specification: Strength of Instrumental Variables in 2SLS

This table provides diagnostics for model specification and instrumental variables in a 2SLS regression. The two structural equations are (1) WPC=linear function(FOWN, Z); and (2) FOWN=linear function(WPC, Z), where Z is the set of 41 exogenous variables including the constant intercept, seven other economic variables, two legal variables (rule of law and legal origin), 22 country dummies, and nine industry dummies. We first test for the strength of the instrument. Panel A summarizes the analysis when the dependent variable is the earliest quintile WPC (the first 20%) and FOWN, respectively. Panel B summarize the analysis when the dependent variable is the last quintile WPC (the last 20%) and FOWN, respectively. VOM, SPD, and VOL are measured over the relevant trading intervals that correspond to the first and last 20% WPCs, respectively. The R^2 and adjusted R^2 are from the regression of endogenous variables on all 41exogenous variables. The F-statistic tests for the significance of the coefficient on the exogenous variable.

Panel A: First Stage OLS Regression for the First 20% Trading Interval

	Dependent Variable WPC	Dependent Variable FOWN
Exogenous Variable	F-Statistic (p-value)	F-Statistic (p-value)
(1) SIZE	1.74 (0.19)	14.12 (0.00)
(2) VOM	5.60 (0.02)	5.16 (0.02)
(3) SPD	62.19 (0.00)	3.53 (0.06)
(4) VOL	3.14 (0.08)	0.01 (0.99)
(5) IWF	0.63 (0.43)	117.76 (0.00)
(6) DR_CRO	0.44 (0.51)	20.38 (0.00)
(7) NOA	4.21 (0.04)	31.51 (0.00)
(8) Rule of Law	30.58 (0.00)	1.85 (0.17)
(9) Legal Origin	2.72 (0.10)	15.52 (0.00)
CDUM, IDUM	Yes	Yes
R^2	0.526	0.337
Adjusted R^2	0.513	0.320

Panel B: First Stage OLS Regression for the Last 20% Trading Interval

	Dependent Variable WPC	Dependent Variable FOWN
Exogenous Variable	F-Statistic (p-value)	F-Statistic (p-value)
(1) SIZE	1.21 (0.27)	2.42 (0.12)
(2) VOM	0.36 (0.55)	2.32 (0.13)
(3) SPD	3.08 (0.08)	2.89 (0.09)
(4) VOL	89.01 (0.00)	4.12 (0.04)
(5) IWF	2.17 (0.14)	107.72 (0.00)
(6) DR_CRO	0.02 (0.89)	20.07 (0.00)
(7) NOA	5.19 (0.02)	30.21 (0.00)
(8) Rule of Law	15.68 (0.00)	0.55 (0.46)
(9) Legal Origin	0.12 (0.73)	8.47 (0.00)
CDUM, IDUM	Yes	Yes
R^2	0.569	0.341
Adjusted R^2	0.557	0.324

Table 9 The Determinants of Price Discovery and Foreign Ownership: 2SLS and 3SLS Analysis

This table reports 2SLS and 3SLS analysis of the determinants of price discovery and foreign ownership. The two structural equations are (1) WPC=linear function(FOWN, Z); and (2) FOWN=linear function(WPC, Z), where Z is the set of 41 exogenous variables including the constant intercept, seven other economic variables, two legal variables (rule of law and legal origin), 22 country dummies, and nine industry dummies. The analysis is presented for the first 20% and last 20% quintile groups. The table also reports statistics (p-value) for two sets of exogeneity test of the left hand side variable (Wooldridge score test and regression-based test), over-identifying restriction test, and five sets of Hausman specification test. The first two Hausman specification test examines the null hypothesis that the estimates on FOWN (or WPC) from OLS and 2SLS are the same. The third and fourth Hausman specification test examines the null hypothesis that the estimates on the two legal variables are the same from OLS and 2SLS. The last Hausman specification test examines the null hypothesis that the rest of the parameters are the same from OLS and 2SLS. * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

	2SLS				3SLS			
	First 20%		Last 20%		First 20%		Last 20%	
	WPC	FOWN	WPC	FOWN	WPC	FOWN	WPC	FOWN
FOWN (Instrumented)	0.161		-0.166		0.165		-0.166	
	(2.77)**		(-2.88)**		(2.77)**		(-2.84)**	
WPC (Instrumented)		0.043		-0.038		0.043		-0.037
		(0.83)		(-0.83)		(0.72)		(-0.87)
SIZE		0.005		0.005		0.005		0.005
		(2.75)**		(2.85)**		(3.23)**		(3.23)**
VOM	-0.003		0.001		-0.003		-0.001	
	(-1.80)*		(0.09)		(-1.99)**		(-0.01)	
SPD×100	-0.039		0.022		-0.039		0.021	
	(-7.84)**		(2.25)**		(-10.39)**		(4.74)**	
VOL ×100	0.023		0.031		0.023		0.031	
	(1.82)*		(9.46)**		(9.04)**		(20.68)**	
IWF		0.110		0.110		0.109		0.110
		(11.17)**		(11.18)**		(14.58)**		(14.78)**
DR_CRO		0.020		0.020		0.020		0.020
		(4.55)**		(4.58)**		(4.87)**		(4.84)**
NOA		0.016		0.016		0.017		0.016
		(5.48)**		(5.31)**		(7.12)**		(7.03)**
Rule of Law	0.035		-0.019		0.035		-0.019	
	(5.20)**		(-3.86)**		(6.02)**		(-3.70)**	
Legal Origin		-0.037		-0.038		-0.036		-0.038
		(-3.14)**		(-3.33)**		(-1.95)*		(-2.06)**
Intercept	0.183	-0.050	0.273	-0.028	0.182	-0.051	0.273	-0.029
	(3.61)**	(-2.88)**	(7.17)**	(-1.82)*	(4.28)**	(-2.48)**	(7.12)**	(-1.68)*
CDUM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IDUM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exogeneity Test 1 (p-value)	1.00 (0.32)	0.21 (0.65)	0.07 (0.79)	1.78 (0.18)				
Exogeneity Test 2 (p-value)	0.98 (0.32)	0.21 (0.65)	0.07 (0.79)	1.62 (0.20)				
Over-Identifying Restriction	4.79 (0.31)	5.15 (0.16)	5.64 (0.23)	2.65 (0.45)				
Hausman Test for FOWN	0.99 (0.32)		0.07 (0.79)					
Hausman Test for WPC		0.21 (0.65)		1.68 (0.20)				
Hausman Test for Rule of Law	0.54 (0.46)		0.04 (0.84)					
Hausman Test for Legal Origin		0.09 (0.76)		0.06 (0.80)				

Hausman Test for Other Variables	0.91 (0.82)	0.20 (0.99)	0.07 (0.99)	1.62 (0.80)				
R^2	0.525	0.338	0.575	0.341	0.525	0.338	0.575	0.341
Observations	1504	1504	1504	1504	1504	1504	1504	1504

Table 10 Analysis of the Impact of Unobservable Confounding Variables for the Association between Price Discovery and Foreign Ownership

Panels A and B provide an assessment of the impact of an unobservable confounding variables on the coefficient of FOWN in the regression of WPC on (FOWN, Z) based on the method developed in Frank (2000). Z is the set of 41 exogenous variables. The table first presents elements necessary to calculate the impact threshold for a confounding variable (ITCV) in Equation (18) of Frank (2000). These include the $R^2_{WPC\bullet Z}$, $R^2_{FOWN\bullet Z}$, $r_{WPC\bullet FOWN}|_Z$, degree of freedom, and critical t-statistics at 5 and 10 percent respectively. $R^2_{WPC\bullet Z}$ and $R^2_{FOWN\bullet Z}$ are the R-squares from regressing WPC and FOWN respectively on Z. $r_{WPC\bullet FOWN}|_Z$ is the partial correlation coefficient between WPC and FOWN, controlling for the effects of all 41 exogenous variables in Z. The degree of freedom is equal to 1504 – 41 = 1463. Suppose we have a unobservable confounding variable CV, then the ITCV is the minimum value of $r_{WPC\bullet CV}|_Z \times r_{FOWN\bullet CV}|_Z$ that would lead to the inference on FOWN to be marginal with a t-statistic of 1.96 (instead of 3.73 in Table 7 and -1.96 (instead of -4.37 in Table 7). The corresponding $r_{WPC\bullet CV}|_Z$ and $r_{FOWN\bullet CV}|_Z$ implied by the minimum ITCV is also tabulated (Equation (16) of Frank (2000)). The table next examines the impact of existing seven exogenous variables and two legal variables, where CV is set to be one of the nine exogenous economic variables. $PC_1 = r_{WPC\bullet CV}|_{Z'}$ is the partial correlation coefficients between WPC and CV after controlling for Z', which includes the remaining 40 exogenous variables. $PC_2 = r_{FOWN\bullet CV}|_{Z'}$ is defined in a similar way. The last column reports the impact coefficient k = $PC_1 \times PC_2$, which can be compared with ITCV value. A small magnitude of k in absolute value relative to ITCV value indicates that the influence on FOWN is small by the exogenous variable under consideration. The table also reports the estimated coefficients and t-statistics when FOWN is regressed on (WPC, Z). * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Panel A: The Dependent Variable is the First 20% WPC

$R^2_{WPC\bullet Z}$	$R^2_{FOWN\bullet Z}$	$r_{WPC\bullet FOWN}\|_Z$	Implied $r_{WPC\bullet CV}\|_Z$	Implied $r_{FOWN\bullet CV}\|_Z$	ITCV	Degree of Freedom (d.f.)	Critical t(d.f.) (p-value)
0.526	0.337	0.0796	0.1191	0.1408	0.0168	1463	1.96 (0.025)
			or -0.1191	-0.1408			
			0.1347	0.1593	0.0215	1463	1.65 (0.050)
			or -0.1347	-0.1593			

Variable	$PC_1 = r_{WPC\bullet CV}\|_{Z'}$	$PC_2 = r_{FOWN\bullet CV}\|_{Z'}$	Impact k = $PC_1 \times PC_2$
(1) CV = SIZE	0.0417	0.0958	0.0040
(2) CV = VOM	-0.0669	-0.0599	0.0040
(3) CV = SPD	-0.2623	-0.0422	0.0111
(4) CV = VOL	0.2307	-0.0003	-0.0001
(5) CV = IWF	0.0199	0.3587	0.0071
(6) CV = DR_CRO	0.0168	0.1239	0.0021
(7) CV = NOA	0.0607	0.1844	0.0112
(8) CV = Rule of Law	0.1586	0.0231	0.0037
(9) CV = Legal Origin	0.0474	-0.0659	-0.0031

Panel B: Panel A: The Dependent Variable is the Last 20% WPC

$R^2_{WPC \bullet Z}$	$R^2_{FOWN \bullet Z}$	$r_{WPC \bullet FOWN \mid Z}$	Implied $r_{WPC \bullet CV \mid Z}$	Implied $r_{FOWN \bullet CV \mid Z}$	ITCV	Degree of Freedom (d.f.)	Critical t(d.f.) (p-value)
0.569	0.341	-0.1346	0.1781	-0.2200	-0.0392	1463	-1.96 (0.025)
			or -0.1781	0.2200			
			0.1867	-0.2309	-0.0431	1463	-1.65 (0.050)
			or -0.1867	0.2309			

Variable	$PC_1 = r_{WPC \bullet CV \mid Z'}$	$PC_2 = r_{FOWN \bullet CV \mid Z'}$	Impact k = $PC_1 \times PC_2$
(1) CV = SIZE	-0.0310	0.0430	-0.0013
(2) CV = VOM	0.0182	0.0449	0.0008
(3) CV = SPD	0.1135	0.0913	0.0104
(4) CV = VOL	0.4691	-0.0485	-0.0228
(5) CV = IWF	-0.0368	0.3475	-0.0128
(6) CV = DR_CRO	-0.0036	0.1239	-0.0004
(7) CV = NOA	-0.0685	0.1851	-0.0127
(8) CV = Rule of Law	-0.0958	0.0132	-0.0013
(9) CV = Legal Origin	-0.0091	-0.0528	0.0005

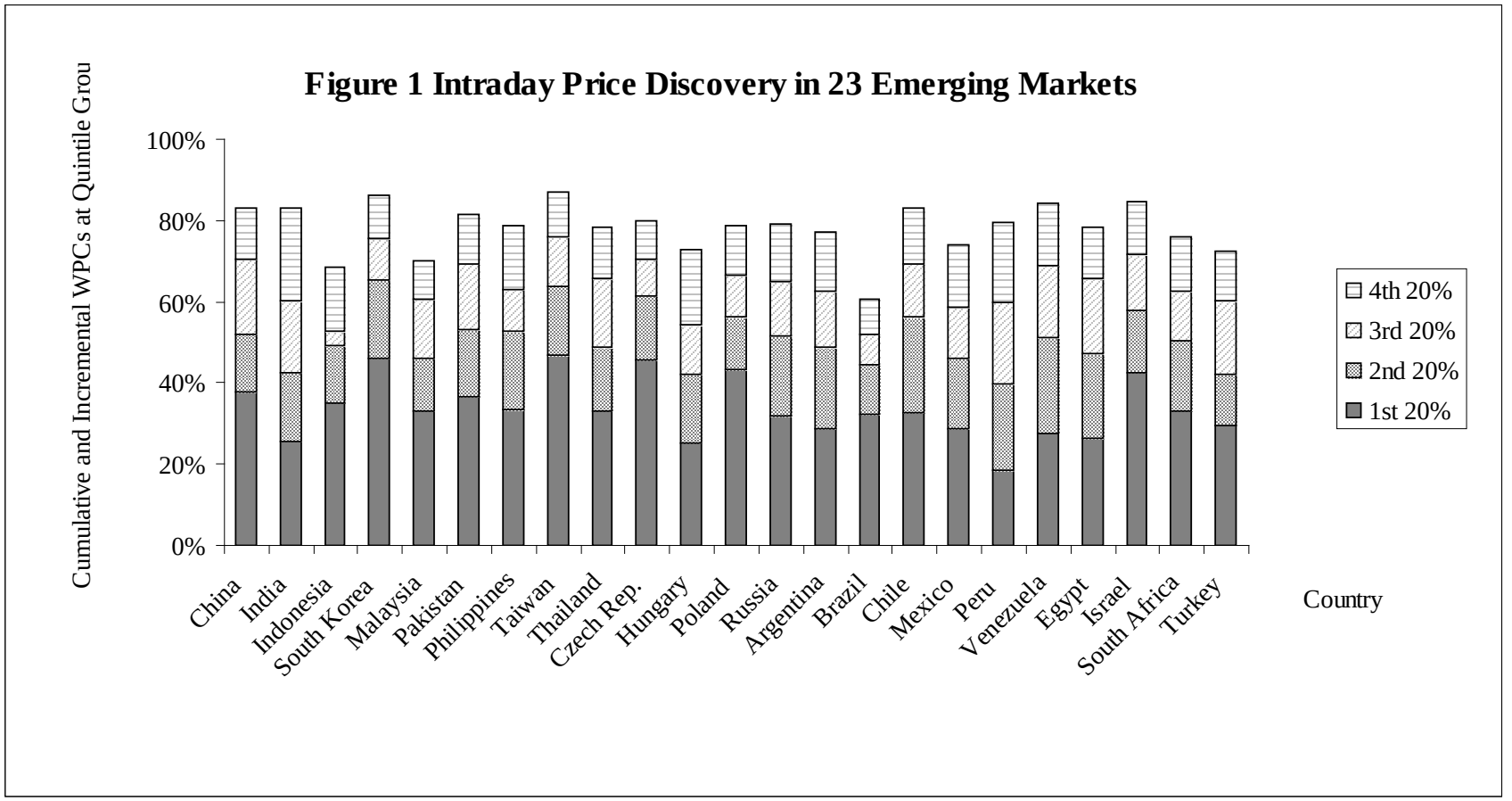

Figure 1: For each market the figure shows the average WPCs for each market split by the period of the day the jth 20% denotes the jth time quintile of the trading day. The fifth quintile is not illustrated, but brings the height of each column to 100%.