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Analyzing frequent acquires in emerging markets and futures markets linkage

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Analyzing frequent acquires in emerging markets and futures markets linkage

A dissertation

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by

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Dedication

This dissertation is dedicated to my beloved wife, Iman. Her love, patience, and support made my research possible. Her words of encouragement sustained me through the difficult moments of this journey. Iman, you have my deepest gratitude.

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Abstract

The first chapter of this dissertation examines the returns to frequent acquirers from emerging markets and analyzes the cross-country variations in cumulative abnormal returns. The sample consists of 5,147 transactions carried out by firms from 17 common and civil-law countries during the period of January 1985 to June 2008. I find that the cumulative abnormal returns decline over the deal order and it is more pronounced in civil-law countries than in common-law countries. There is also evidence that the premiums paid by acquirers from civil-law countries with a first successful acquisition are higher than those from common-law countries. These findings are consistent with agency problems and the hubris hypothesis, first introduced by Roll (1986).

The second chapter examines the information links across futures markets in different nations, using Vector Autoregressive (VAR)-Dynamic Conditional Correlation (DCC) model. The data comprise a large set of commodity and financial futures traded in U.S., U.K., China, Japan, Canada, and Brazil during the period from August 1998 to December 2008. The primary finding is that market interactions are relatively high for commodities for which information production generally is more diverse (metal commodities), while moderate for commodities for which information is more concentrated (agricultural commodities). Furthermore, the strength and persistence of interactions among futures markets decline after excluding the most informative markets. These findings indirectly support the breadth of information being a relevant factor in the extent of information linkage. The results also indicate that the dynamic correlation in futures markets is high in most commodity and financial futures if there is a significant bi-directional return and volatility spillover. Additionally, I estimate a market's contribution to the price discovery process. In general, the market that has a stronger price impact and a stronger volatility spillover tends to be the market that has greater contribution or leadership in price discovery.

Keywords: Frequent acquirers, hubris, agency problem, emerging markets, CAR, futures markets, breadth of information, price discovery, Dynamic Conditional Correlation,

Introduction

This dissertation consists of two essays. The first essay of my dissertation examines the returns to frequent acquirers from emerging markets and analyzes the cross-country variations in cumulative abnormal returns (CARs). The existing literature on repeated mergers suggests that agency cost and the hubris behavior might have explanatory power in accounting for the declining returns for an acquirer involved in repeat acquisitions. However, similar studies appear to be nonexistent for emerging countries. An investigation of the emerging markets focusing on the agency issues is worthwhile, since emerging markets are characterized by generally high agency problems and poor investor protection. By examining multiple countries, we can also determine whether differences in legal systems and investor protection is a factor in merger activities.

This essay focuses on the implications of agency problems and hubris hypothesis on the returns of repeated acquirers in emerging countries. More specifically, I compare abnormal returns of repeated acquirers depending on the legal environments within which these firms operate, using a sample of 5,147 transactions carried out by firms from 17 common and civil-law countries during the period of January 1985 to June 2008. I find that the cumulative abnormal returns decline over the deal order and it is more pronounced in civil-law countries than in common-law countries. This observation suggests that the value destructive to acquiring firms in civil-law counties is more pronounced than that in common-law countries in higher order deals. There is also evidence that premiums paid by acquirers from civil-law countries with first successful acquisition are higher than those from common-law countries. These findings are consistent with agency problems and the hubris hypothesis first introduced by Roll (1986).

The second essay of my dissertation examines the information links across futures markets in various nations, utilizing the VAR-DCC model. While prior studies have analyzed the interaction between futures markets by examining the information transmission across commodity markets, most of these studies examine a fairly small number of commodities and markets. Additionally, reasons for variations in the futures markets' interactions are not clear. No study to my knowledge examines whether or why the degree of market interaction might vary across markets and commodities.

This essay examines the degree of interaction across the world futures markets in similar commodity futures. The data comprise a comprehensive set of futures prices in commodity and financial futures traded in U.S., UK, China, Japan, Canada, and Brazil over the period from August 1998 to December 2008. The commodity and financial futures include: agricultural futures (coffee, corn, soybeans, and wheat), metal futures (aluminum, copper, and gold), and financial futures (India S&P CNX Nifty index futures and Japan Nikkei 225 index futures).

The primary finding of this essay is that the market interactions are relatively high for commodities for which information production is more diverse (e.g. metal commodities) and relatively moderate for commodities for which information is more concentrated (e.g. agricultural commodities). This makes sense because production such as corn is more concentrated in few markets; therefore less markets interaction is expected. Furthermore, I compare the persistence of interaction including and excluding the most important market; I find in most cases a substantial reduction in the degree of persistence when the most important markets are excluded. This indirectly supports the information breadth being a relevant factor in the extent of information link. While this conclusion might seem obvious, no studies to my knowledge quantify this. The results also indicate that the dynamic correlation for futures markets is high in most commodity and financial futures if there is a significant bi-directional return and volatility spillover. Additionally, the study estimates the contribution of the price discovery process from different markets on the same asset. The market that has a stronger price impact and a stronger volatility spillover tends to be the market that has the greater contribution in the price discovery process (i.e. greater futures price leadership).

Chapter 1

The Performance of Frequent Acquirers: Evidence from Emerging Markets

1. Introduction:

In general, empirical papers[1] on frequent corporate acquirers find that stock price reactions become less favorable as they acquire more and more firms. These studies investigate acquisitions in developed countries and offer several hypotheses and theoretical explanations relating to the impact of the number of acquisitions on repeated acquirers' performance. For example, Rosen (2005) relates the declining returns for successive acquisitions to agency issues. He provides evidence of a positive relation between a firm with a merger program and excess compensation of this firm's CEO. Conn, Cosh, Guest, and Hughes (2004) and Billett and Qian (2005) link declining returns of repeat acquisitions to the hubris hypothesis, first proposed by Roll (1986).

The existing literature on repeated mergers suggests that agency cost and the hubris behavior might have explanatory power in accounting for the declining returns for an acquirer involved in repeat acquisitions. However, similar studies appear to be nonexistent for emerging countries. An investigation of the emerging markets focusing on the agency issues is worthwhile, since emerging markets are characterized by generally high agency problems and poor investor protection.

Two additional reasons for taking up the issue are 1) phenomenal growth in mergers and acquisitions (M&As) activities in emerging markets, and 2) institutional differences between emerging versus developed markets. The trade liberalization policies of emerging countries have caused domestic firms to become involved in domestic acquisitions to combat the fierce

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[1] Fuller, Netter, and Stegemoller, 2002; Billett and Qian, 2005; Conn, Cosh, Guest, and Hughes, 2004; Rosen, 2005; and Ahern, 2008 report a declining trend in cumulative abnormal returns (CARs) of repeated acquirers of public firms in U.S. and UK.

competition from abroad. Recently, the data obtained from Securities Data Company's (SDC) World-Wide M&As data base indicates that the M&As activity, undertaken by firms from emerging countries, is relatively intense in terms of value. The total value of M&As transactions increased from $10.47 billion (4% of total value of world M&As transactions) in 1990 to $189.8 billion (11% of total value of world M&As transactions) in 2007, which is a 17-fold increase during the period of 1990-2007. Flanagan, Milman, D'Mello (1997) show that M&As activity in Latin America by local and international acquirers increased tenfold between 1984 through 1994 because of the introduction of new economic and investment policies in emerging markets.

The capital market in emerging countries is unique in terms of a number of institutional features. These include, high information asymmetry[2] (Bhattacharya and Daouk, 2002; Durnev, Morck, Yeung, and Zarowin, 2003; Jin and Myers, 2006), market illiquidity (Lesmond, 2005; Choe, Kho, and Stulz, 2005), and poor investor protection (Dyck and Zingales, 2004; Djankov, La Porta, Lopez-de-Silanes, and Shleifer, 2008). These particular market features may alter the documented performance pattern for repeated acquirers, since these features are likely more severe than the developed market despite the liberalization efforts[3] that are undertaken by most of emerging countries.

Although institutional differences (and issues related to this) separate emerging markets from developed markets, the former cannot be treated as one cohesive group as substantial differences (institutional, legal, political etc.) exist across emerging markets. The institutional governance infrastructure in the emerging countries varies considerably across emerging markets

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[2] Information asymmetry in this context includes: insider trading regulations, financial disclosures, and domestic vs. foreign information advantages.

[3] Since 1990, governments of emerging markets have adopted an economic reform program, which aims at liberalizing and modernizing their economies in order to be more competitive at the regional and international levels and integrating them into the world economy. The accession to WTO, signing of new regional trade agreements, creating an administrative and investment climate to encourage domestic and foreign investment, and privatization of state owned enterprises are undertaken as major elements of the broad new economic strategy being followed by most emerging countries.

based on the legal system of individual country. La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997, 1998, 2000) show that common-law countries (civil-law countries) provide high (low) level of protection to both shareholders and creditors[4]. They also provide empirical evidence that different legal systems have a considerable impact on the quality of country's institutions (e.g. common-law countries have better institutions, lower level of corrupt governments, and more efficient courts than the civil systems) and accordingly, firms in common-law countries rely more on stock markets to raise new capital (La Porta, Lopez-de-Silanes, Shleifer, and Vishny, 1997) and have less concentrated shareholder ownership (La Porta, Lopez-de-Silanes, and Shleifer, 1999). Further, countries with better investor protection have a more active market for mergers and acquisitions than that of lesser investor protection countries (Rossi and Volpin, 2003). Boubakri, Dionne, Triki (2006) show positive returns are significantly higher for bidder shareholders in countries where investor protection is better.

Major objectives of this study are twofold: 1) to examine the market reaction to acquirers' announcements of repeated acquisitions in emerging countries, and 2) to analyze whether agency problems and the hubris explanation can explain the cross-country variations in cumulative abnormal returns experienced by frequent acquirers. For the second purpose, I examine if abnormal returns differ depending on whether the repeated acquirer resides in a civil law country or in a common law country. La Porta, Lopez-De-Silanes, Shleifer, and Vishny (1997) suggest that ownership and investor protection differ between these two legal systems. Several studies have confirmed the implications of the differences in the legal environment.

[4] Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008) develop a new measure to quantify the degree of legal protection of minority shareholders against expropriation by corporate insiders (anti-self dealing index). The countries with lower scores on the index provide more opportunities for minority shareholder expropriation as reflected by, the anti-self dealing index for Mexico (0.17), Brazil (0.27), South Korea (0.47), India (0.58), China (0.78) and Hong Kong (0.96) out of 1.

Given this finding, the hypothesis is that agency problems and hubris behavior are more pronounced for a civil-law acquirer than a common-law acquirer. Since common-law countries are likely to have better monitoring and investor protection, I expect that stock price reactions should be more positive (less negative) for repeated acquirers in common-law countries than in civil-law countries. The study's results support this hypothesis.

The remainder of the paper is organized as follows. Section two reviews previous literature on the performance of single and multiple acquirers and the existing hypotheses used to explain the performance of multiple acquirers as well as the focus of this paper. Section three states the data and methodology. Section four discusses the empirical results. Section five concludes the analysis.

2. Literature Review:

This review summarizes the studies that examine the performance of acquirers from developed economies and their counterparts from emerging countries, followed by a review of studies that are designed to examine the performance pattern of the multiple acquirers.

2.1. M&As' and Acquirers' Performance:

The literature regarding the market reaction to domestic acquisitions in developed stock markets has been extensively studied (Franks, Broyles and Hecht, 1977; Firth, 1979, 1980; Bradley, Desai, and Kim, 1988). While a few studies have observed positive returns to acquirers (Franks, Broyles and Hecht, 1977; Lubatkin, 1987), most have found that acquirers either earn zero (Frank and Harris, 1989) or experience negative gains (Bradley, Desai, and Kim, 1988; Jarrell and Poulsen, 1989; Loderer and Martin, 1990; Murray, 1991). Research on cross border M&As activity is also common especially in the U.S. and UK. While some studies show positive returns from cross border M&As (Fatemi and Furtado, 1988; Morck and Yeung, 1992; Doukas and Travlos, 1988; Markides and Ittner, 1994), few studies show a negative announcement period return for the bidding firms (Datta and Puia, 1995; Danbolt, 1995; Kiymaz and Mukherjee, 2000).

In emerging countries, a very limited amount of research has investigated the wealth creation associated with the acquiring companies. Pangarkar and Lie (2004) analyze 115 acquisitions by Singapore firms during the period of 1990-1999 and report that the acquirers experience significant positive cumulative abnormal returns (CARs). Yao (2004) examines the impact of M&As' activity on the return and future performance of 36 high-tech firm in Taiwan from (1996-2001) and finds that the acquirers earn short term positive abnormal returns. Wang and Boateng (2007) restrict their study to Chinese acquirers who acquired foreign firms. They examine the impact of acquisition announcements on shareholder wealth of Chinese listed companies engaged in 27 cross border M&As deals over the five year period of 2000-2004. They find that cross border M&As create value to shareholders of the acquirer firms and those acquirers earn positive cumulative abnormal returns for a two-day period. They report that the cross-border acquisitions by Chinese firms are motivated by market development and power through increased market share and strategic knowledge sourcing.

2.2. Performance of Repeated Acquirers:

Most of the empirical studies concerning the performance of the multiple acquirers have used U.S. and UK stock market data with no emphasis being given to multiple acquirers from emerging countries. In the following section, I review the studies that examine the pattern of the frequent acquirers in developed countries and the existing hypotheses that are offered to explain the pattern. These include: agency problems and the hubris hypothesis and other hypotheses (liquidity discount, opportunity set hypothesis, capitalization hypothesis, and signaling theory).

2.2.1. Agency Problems and Hubris Hypothesis:

The empirical results on the relevance of agency problem in acquisitions are somewhat mixed. Moeller, Schlingemann, and Stulz (2004) report that abnormal returns associated with acquisition announcement by large acquirers are less than that of small acquirers. They suggest that the size effect might be caused by agency issues; however, no tests have been provided. Ahern (2008) tests the agency cost hypothesis using the G–index derived by Gompers, Ishii, and Metrick (2003) to measure the managerial entrenchment. He finds weak support for the agency theory. Croci (2005) tests for empire building as one of alternative explanations for why managers undertake serial acquisitions by using a sample of 591 U.S. firms that made five acquisitions within a five year interval over the 1990-2002. He reports that managers undertake repeated acquisitions because of their superior skills. In contrast, Rosen (2005) provides evidence of a positive relation between a firm with merger program and excess compensation of this firm's CEO.

The hubris hypothesis of Roll (1986) suggests that overconfident managers might explain negative reactions to acquiring firms. Aktas, de Bodt, and Roll (2007b) find that the increasing premiums drive down abnormal returns with their bid order. Conn, Cosh, Guest, and Hughes (2004) test the hubris hypothesis among other hypotheses (e.g. overvaluation hypothesis, and accounting manipulation hypothesis) by using a sample of acquisitions by UK firms during 1984-1998. They find empirical evidence that the decline in the acquirer's returns occurs only for an acquirer whose first acquisitions is successful; successive returns actually increase when the first acquisition is unsuccessful. Billett and Qian (2005) provide evidence of association between overconfidence and repeat acquisition decisions and report that frequent acquirers experience negative abnormal returns in higher order deals. Bradley and Sundaram (2004) find evidence that positive market reaction before acquisition stimulates the acquirer to make additional acquisitions.

Hayward and Hambrick (1997) link the agency theory with the hubris hypothesis on a sample of 106 U.S. large acquisitions (over $100 million). They show that, with a high proportion of inside directors, the relationship between CEO hubris (measured by firm's recent performance, recent media praise for the CEO, and CEO's self importance who inherently believe in his/her ability) and premium paid for acquisitions becomes stronger (i.e. CEO hubris is more pronounced when the proportion of inside directors increases). They further find that the boards with a large percentage of outside directors are best able to resist proposed acquisitions by CEO with hubris.

2.2.2. Other Hypotheses:

Other related hypotheses that are used to explain the pattern include liquidity discount, opportunity set hypothesis, capitalization hypothesis, and signaling theory.

Fuller, Netter, and Stegemoller (2002) provide evidence that the bidder returns from acquiring private and subsidiary targets is higher than that of public deals because of the illiquidity premium. Acquiring a public firm requires a liquidity premium which drives down the returns to the acquirers, particularly those purchased with stock. The acquirer's return continues to be negative through the fifth and even more acquisitions when a public target is acquired with stocks. In contrast, when a target is a private firm, the acquiring firm receives a positive return as it is able to buy the target at an illiquidity discount regardless of the method of payment used. The positive stock price reaction for the acquiring firm continues through the fifth or more acquisitions when the target is a private firm. Similarly, Conn, Cosh, Guest, and Hughes (2005) examine the announcement returns of 4,000 acquisitions by UK public firms during 1984-1998 and find that acquisitions of private targets result in positive announcement returns while the reactions for acquisitions of public targets are negative.

The opportunity set hypothesis of Klasa and Stegemoller (2007) predicts that the sequences of the acquisition are attributed to the change in the investment opportunity set. They find evidence to suggest that the acquirer's abnormal returns decline for subsequent bids because of the declining investment opportunity set over time.

The capitalization hypothesis of Schipper and Thompson (1983) suggests that the market capitalizes the entire benefit of subsequent acquisitions in the first announcement of the program. On average, a later acquisition has no return. Using 55 U.S. firms that engage in acquisition programs during the period of 1952-1968, they find that the market reacts positively to the announcement of a merger program. However, later acquisitions have a lower return.

Signaling theory-based arguments have not had much success in explaining repeated acquirer's returns. Indeed, the evidence reported by Asquith, Bruner, and Mullins (1983) is inconsistent with the signaling prediction. Asquith, Bruner, Mullins (1983) hypothesize that each subsequent deal conveys less information than prior deals since the market has learned more about the acquirer. Based on a sample of U.S. firms involved in repeat mergers (up to four) during 1963-1979, the bidder returns remain positive through the fourth bid. Ahern (2008) tests a signaling theory prediction that dispersion of returns (a measure of information asymmetry related to an acquisition) decreases with bid number, but he finds no significant reduction in dispersion.

2.3. Focus of the Paper

This paper focuses on the implications of agency problems and the hubris hypothesis on the returns of repeated acquirers in emerging countries. More specifically, the abnormal returns of repeated acquirers depending on the legal environments within which these firms operate are compared. There is preponderance of evidence to suggest that investor protection is poor in civil-law countries. A similar argument applies to the corporate governance system in civil-law countries. Kim, Kitsabunnarat, and Nofsinger (2005), among others, find that countries with stronger investor protection rights have firms with more outside directors since the minority shareholders are weak to affect board composition. This suggests that board characteristics in civil-law countries with weak investor protection is less likely to resist major acquisitions' proposals or even overbidding by a CEO with hubris behavior.

Applying the hubris hypothesis to emerging markets, the study expects that a successful first acquisition builds overconfidence (hubris) for the acquirer who then overpays for subsequent acquisitions and consequently its returns declines with each successive bid. Furthermore, if the hubris behavioral tendency is stronger in civil-law countries, the decline in subsequent performance will be more pronounced for acquirers in civil-law countries than those in common-law countries. I also expect that the premium paid for acquisitions in the civil-law countries to be larger than those premiums in common-law countries due to the lack of sufficient institutional governance infrastructure in the civil-law countries.

3. Data and Methodology

3.1. Sample Details:

The sample firms are identified from the Securities Data Corporation (SDC) Mergers and Acquisitions database. These firms make multiple acquisitions between January 1, 1985 and June 30, 2008. Following the prior literature, only acquisitions that were completed within 1,000 days (the time between completion date and announcement date) are included in the sample. The acquirers must be in the Wharton Research Data Services (WRDS)/ Compustat Global, thereby providing firm level information. The focus of this study is with the public acquiring firms that make acquisitions of public, private and subsidiary firms. Acquirers and targets are not a utility or a financial institution (Fuller, Netter, and Stegemoller, 2002). Clustered acquisitions where the bidder acquires two or more firms within five days have been excluded (Fuller, Netter, and Stegemoller, 2002). Daily stock prices, adjusted for dividends and splits are obtained from WRDS/ Compustat Global.

The study defines a frequent acquirer as a public firm that acquires at least two targets within any five-year horizon over the sample period (Billett and Qian, 2005). Deal order is defined based on a rolling 5-year window (Billett and Qian, 2005). If the firm acquired five acquisitions within the last five year history, then the current deal order is six. The short-term abnormal returns to frequent acquirers from emerging countries are examined. These countries are subdivided into two groups based on differences in legal system. These groups include common legal origin: Malaysia, India, South Africa, Hong Kong, Singapore, New Zealand, and civil legal origin: South Korea, Norway, Greece, Brazil, Russia, Taiwan, China, Mexico, Poland, Portugal, Philippines. They collectively account for about 85% of M&As activities that were undertaken by firms from emerging countries. The rest of the emerging markets have an insufficient number of transactions to permit analysis after matching their extracted acquisitions announcements with stock price data from WRDS.

Table 1 Panel A displays the acquisitions originating from firms in common-law countries while panel B shows the corresponding sample in civil-law countries. For common-law countries, the screening criteria results in a sample of 2,645 acquisitions made by 824 frequent acquirers during the sample period 1985-2008. The median number of deals completed by a single firm is 2.5 deals over the sample period. Further, the median value of the total value of transactions is $8.15 million during the sample period. For the breakdown of the completed deals according to deal order series, Table 1 Panel A, shows that for the frequent acquirer from common-law countries, the first acquisition accounts for 24.08% of total completed deals, for second and third deals (2^{nd}&3^{rd} hereafter) equal 46.92%, and for the fourth deal (4^{th} deal hereafter) and greater (combining all deals with a deal order of four or more) equal 29%. Panel A also shows that Malaysia and India are the most important ones in terms of total number of deals that carried out during the study period. In term of dollar amount, Hong Kong has the largest average deal size and total size.

In contrast, Table 1 Panel B shows that the number of acquisitions carried out by civil-law countries is 2,502 acquisitions and made by 711 firms. This finding is consistent with (Rossi and Volpin, 2003) in which the volume of M&As activity is less active in countries with lesser investor protection. The median number of deals completed by one firm is three deals over the sample period. Further, the median value of the total value of transactions is $15.21 million during the sample period. As for the breakdown of the completed deals according to deal order series, Table 1 Panel B reveals that for the frequent acquirer from civil-law countries, the first acquisition account for 21.58% of total completed deals, for 2^{nd}&3^{rd} acquisitions equal 41.17%, and for the 4^{th} deal and greater equal 37.25%. Panel B also shows that South Korea and Norway are the most important ones in terms of total number of deals that carried out during the study period. In term of dollar amount, however, Mexico has the largest average deal size and total size.

Table 1

Summary of M&As Activity for Frequent Acquirers by Country

The table reports transaction and the final merger clean sample of frequent acquirer for each country. Panel A and B display the summary of M&As' activity for frequent acquirers from common and civil-law countries, respectively. Each panel reports the number of deals, number of acquiring firms, the median number of completed acquisitions by a firm over the sample period (Jan 1985-Jun 2008), the breakdown of completed acquisitions by deal order, the total value of transaction that are supplied by SDC in ($ millions), and the median of transaction value for each country. The transaction value is the total value of consideration paid by the acquiring firm, excluding fees and expenses. Frequent acquirer is defined as a public firm that acquires at least two targets within any five-year horizon over the sample period. Deal order defined based on a rolling 5-year window (i.e. if the firm acquired seven acquisitions within the last five year history, then the present deal order is eight). N1 is the number of completed acquisitions with a deal order of one. N2 is the number of completed acquisitions with a deal order of two and three. N3 is the number of completed acquisitions with a deal order of more than three.

Country	No. of deals	No. of firms	Median no. of deal	No. of announcements by deal order						Transaction value (mill$)	
				1st		2nd – 3rd		>3rd			
				N1	%	N2	%	N3	%	Total	Median
Panel A: Acquirer from common-law countries											
Malaysia	730	256	2.00	210	28.77	403	55.21	117	16.03	12,176.67	2.35
India	493	150	2.00	118	23.94	224	45.44	151	30.63	17,619.80	15.08
South Africa	427	109	3.00	94	22.01	184	43.09	149	34.89	31,407.21	23.92
Hong Kong	381	112	2.00	88	23.10	168	44.09	125	32.81	79,732.74	22.30
Singapore	389	148	3.00	85	21.85	180	46.27	124	31.88	18,911.64	1.97
New Zealand	225	49	3.00	42	18.67	82	36.44	101	44.89	7,616.46	13.95
All common-law countries	***2,645***	***824***	**2.5**	***637***	**24.08**	***1,241***	**46.92**	***767***	**29.00**	***167,464.52***	***8.15***
Panel B: Acquirer from civil-law countries											
South Korea	579	216	2.00	177	30.57	303	52.33	99	17.10	47,751.76	8.08
Norway	548	107	4.00	68	12.41	171	31.20	309	56.39	71,390.40	17.84
Greece	234	68	3.00	54	23.08	106	45.30	74	31.62	11,905.23	8.85
Brazil	188	45	3.00	40	21.28	69	36.70	79	42.02	55,162.49	68.50
Russia	177	33	6.00	15	8.47	42	23.73	120	67.80	41,533.41	68.33
Taiwan	165	52	2.00	52	31.52	74	44.85	39	23.64	25,827.79	24.00
China	147	72	2.00	44	29.93	82	55.78	21	14.29	16,261.67	10.65
Mexico	145	30	4.00	21	14.48	46	31.72	78	53.79	71,521.78	63.93
Poland	140	39	3.00	30	21.43	56	40.00	54	38.57	4,091.62	2.83
Portugal	121	28	3.00	23	19.01	49	40.50	49	40.50	10,038.77	31.15
Philippines	58	22	2.00	16	27.59	32	55.17	10	17.24	2,718.09	9.91
All civil-law countries	***2,502***	***711***	**3.00**	***540***	**21.58**	***1,030***	**41.17**	***932***	**37.25**	***358,203.01***	***15.21***

Table 2 reports the distribution of M&As activity by industry for common and civil-law countries using the 49 Fama and French industry classifications. In common-law countries, business services (9.8%), transportation (6.6%), computer software (5.8%), wholesale (5.8%), construction material (5.0%) and electronic equipment (4.6%), are the largest acquiring industries which together account for 37.6% of all multiple deals. These industries, except the electronic equipment, are the most important targets for merger, accounting for 37.2% of all target firms in these industries. Whereas, in civil-law countries, electronic equipment (8.0%), computer software (7.9%), communication (7.3%), business services (6.1%), transportation (5.6%) and petroleum and natural gas (4.6%), are the largest acquiring industries which together account for 39.5% of all multiple deals. These industries are, also, the most important targets for merger, accounting for 42.9% of all target firms in these industries. The distribution of M&As activity collectively indicates a similarity between acquirers from common and civil-law countries in making acquisitions in specific industries (business services, transportation, electronic equipment and computers software). These industries are among the first top five attractive acquisitions targets for both groups. This industry clustering is among the first top five groups in M&As activity reported in previous literature for repeated acquirers from the U.S. (Ahern, 2008).

Table 2
M&As Activity for Frequent Acquirers by Industry

This table summarizes the M&As activity by industry for frequent acquirers from common and civil-law countries. Industry data are sorted using 49 Fama and French industry classifications. Each panel reports detailed information on the number of acquisitions that are carried out by common and civil-law countries in each sector. Column (1) represents the ratio of frequent acquirers in one industry *to* all frequent acquirers. Column (2) is the number of firms that make multiple bids (3) represents the ratio of firms that are targets to frequent acquirers in one industry *to* all target firms. Column (4) is the number of firms that are targets to frequent acquirers. Column (5) is the number of acquired bids from the same industry as the frequent acquirer. Column (6) is ratio of acquired bids from the same industry as the frequent acquirer *to* all acquired bids.

Industry sector	Acquiring firm		Target		No. of own industry acquisition	% Bids in own industry
	%	N	%	N		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Acquirer from common-law countries						
Beer & Liquor	0.5	5	0.6	9	11	78.6
Candy & soda	0.5	5	0.6	13	6	46.2
Food products	2.8	33	3.7	58	36	49.3
Tobacco Products	0.3	3	0.1	2	1	14.3
Agriculture	2.5	21	1.6	27	22	33.3
Aircraft	0.0	0	0.0	0	0	0.0
Apparel	0.8	12	0.7	16	9	40.9
Automobiles and Trucks	2.8	27	1.8	33	26	35.1
Business Services	9.5	85	10.5	196	94	37.3
Business Supplies	1.1	10	1.4	22	15	51.7
Chemicals	3.3	33	3.6	58	47	54.0
Coal	0.2	2	0.5	8	4	100
Communication	5.8	36	5.1	63	85	55.6
Computer Software	5.7	50	8.2	118	74	49.3
Computers	1.7	13	1.1	24	9	20.0
Construction	3.4	34	2.5	49	26	28.6
Construction Materials	6.3	43	4.4	64	71	42.8
Consumer Goods	2.9	24	2.4	39	38	48.7
Defense	0.0	0	0.0	0	0	0.0
Electrical Equipment	0.8	12	1.0	22	8	38.1
Electronic Equipment	4.3	40	3.1	54	39	34.5
Entertainment	1.1	10	1.1	19	9	30.0
Fabricated Products	0.6	6	0.9	18	4	23.5
Healthcare	0.9	5	1.1	13	17	70.8
Machinery	1.8	18	1.6	33	4	8.3
Measuring and Control Equipment	0.3	6	0.5	9	3	33.3
Medical Equipment	0.0	1	0.4	9	1	100
Non-Metallic and Industrial Metal Mining	1.6	13	2.0	27	27	62.8
Personal Services	1.3	9	2.0	35	13	37.1
Petroleum and Natural Gas	1.8	14	1.6	27	24	50.0
Pharmaceutical Products	3.4	22	3.7	39	70	77.8
Precious Metals	2.5	11	2.3	16	54	80.6
Printing and Publishing	1.4	11	1.4	22	21	55.3
Recreation	0.8	9	0.9	19	7	35.0
Restaurants, Hotels, Motels	3.3	29	3.1	42	58	65.9
Retail	3.6	29	3.6	61	41	43.2
Rubber and Plastic Products	1.8	19	2.0	33	23	47.9
Shipbuilding, Railroad Equipment	0.2	1	0.3	5	3	50.0
Shipping Containers	0.2	2	0.4	7	1	16.7

Table 2 continued

Industry sector	Acquiring firm % (1)	Acquiring firm N (2)	Target % (3)	Target N (4)	No. of own industry acquisition (5)	% Bids in own industry (6)
Steel Works Etc	3.1	30	2.2	40	29	34.9
Textiles	2.1	20	1.6	26	23	41.8
Trading	0.6	6	0.2	6	2	13.3
Transportation	6.3	57	6.5	88	107	64.5
Wholesale	5.6	50	7.4	127	43	29.1
Panel B: Acquirers from civil-law countries						
Beer & Liquor	1.2	9	0.8	12	18	58.1
Candy & soda	1.2	7	2	23	19	65.5
Food products	5.2	31	3.5	35	64	49.2
Tobacco Products	0.3	3	0.1	1	2	28.6
Agriculture	1.3	7	1.6	24	12	37.5
Aircraft	0	0	0	1	0	0
Apparel	0.8	7	0.4	9	2	10
Automobiles and Trucks	1.7	14	1.4	24	19	44.2
Business Services	6.4	45	7.4	112	68	42.5
Business Supplies	1.8	14	1.8	25	25	56.8
Chemicals	2.8	22	3.4	51	30	43.5
Coal	0.4	3	0.6	8	6	60
Communication	9.9	54	10.6	95	185	74.6
Computer Software	6.6	58	8.6	123	89	53.9
Computers	2.3	22	2.5	44	23	39.7
Construction	3.8	33	3.9	60	61	63.5
Construction Materials	3.7	33	3.1	39	52	56.5
Consumer Goods	1.3	17	1	20	6	18.2
Defense	0	0	0	1	0	0
Electrical Equipment	0.6	9	0.8	20	2	13.3
Electronic Equipment	6.6	59	5.2	87	77	47
Entertainment	0.6	6	1.6	31	7	50
Fabricated Products	0.3	2	0.4	8	0	0
Healthcare	0.9	3	1	7	20	90.9
Machinery	2.1	20	2.8	48	21	40.4
Measuring and Control Equipment	0.4	6	0.5	10	3	30
Medical Equipment	0.6	6	0.4	7	2	14.3
Non-Metallic and Industrial Metal Mining	1.1	7	1.4	17	15	53.6
Personal Services	0.2	2	0.8	17	4	100
Petroleum and Natural Gas	8.8	34	5.9	44	127	58
Pharmaceutical Products	1.4	15	1.7	28	20	57.1
Precious Metals	0.1	2	0.3	5	1	33.3
Printing and Publishing	2.4	10	1.2	16	17	27.9
Recreation	2.3	15	1.2	21	12	20.7
Restaurants, Hotels, Motels	1	10	1.4	20	21	84
Retail	2.3	16	3.2	48	40	70.2
Rubber and Plastic Products	0.9	7	0.8	10	10	45.5
Shipbuilding, Railroad Equipment	0.8	6	1.1	14	8	42.1
Shipping Containers	0.6	5	0.4	7	6	37.5
Steel Works Etc	5	30	4.4	44	68	54.4
Textiles	2	19	1.1	16	16	32.7
Trading	0.4	3	0.2	3	0	0
Transportation	4	41	5.2	77	73	72.3
Wholesale	3.8	26	4.7	89	24	25.5

As for the deals characteristics of the sample, they are divided into four groups. The target origin of the deal (domestic vs. cross border), the industry relatedness (if both target and acquirer have the same three-digit SIC code, they are considered related), the organization form of the target (private, public or subsidiary), and the mode of payment (cash, stock, or combination). Table 3 provides sample statistics for common and civil-law countries across the four different levels of deal characteristics. Relative to acquirers from civil-law countries, on average, acquirers from common-law countries rely significantly more on cross border acquisitions at the 1% level (40.8% vs. 35.9%), are significantly more involved in unrelated acquisitions at the 5% level (62.8.% vs. 58.1%), and have significantly more private and subsidiaries acquisitions at the 5% level (80.0% vs. 77.2%). In contrast, acquirers from civil-law countries are significantly more likely to use mixed offer (cash or stock) to pay for their transactions than those from common-law countries at the 5% level (70.7% vs. 66.4%).

Table 3
Sample Statistics for Frequent Acquirers across Different Deal Characteristics

The table presents sample statistics for all completed mergers and acquisitions of multiple acquirers. Panel A and B present a breakdown of completed deals with respect to target origin (domestic vs. cross border), type of transaction (related vs. unrelated), organizational form of the target (public, private, subsidiary), and payment method (cash, stock, combination) for acquirers from common and civil-law countries, respectively. The target's origin is considered domestic if the target and the acquirer located in the same country, and cross border otherwise. Transactions are classified as related if both target and acquirer have the same three-digit SIC code, and unrelated otherwise. A target is considered public if it is listed on a stock market and private & subsidiary otherwise. All cash includes transactions made only in cash, or cash and debt. All stock defined as transactions made only in common stock to pay for acquisition. Mixed offer is defined as a transaction made in cash and stock and/or convertibles, and method classified by SDC as "other".

	Relatedness				Mode of payment					
	Unrelated		Related		All cash		All stock		Mixed	
Country	N	%	N	%	N	%	N	%	N	%
Panel A: Acquirers from common-law countries										
Malaysia	513	70.3	217	29.7	293	40.1	23	3.2	414	56.7
India	238	48.3	255	51.7	100	20.3	17	3.5	376	76.2
South Africa	245	57.4	182	42.6	84	19.7	44	10.3	299	70
Hong Kong	241	63.3	140	36.7	103	27	18	4.7	260	68.2
Singapore	265	68.1	124	31.9	138	35.5	19	4.9	232	59.6
New Zealand	158	70.2	67	29.8	44	19.6	6	2.7	175	77.8
All common-law countries	***1,660***	***62.8***	***985***	***37.2***	***762***	***28.8***	***127***	***4.8***	***1,756***	***66.4***
Panel B: Acquirers from civil-law countries										
South Korea	395	68.2	184	31.8	245	42.3	41	7.1	293	50.6
Norway	329	60	219	40	100	18.3	20	3.7	428	78.1
Greece	153	65.4	81	34.6	24	10.3	9	3.9	201	85.9
Brazil	78	41.5	110	58.5	46	24.5	3	1.6	139	73.9
Russia	95	53.7	82	46.3	22	12.4	2	1.1	153	86.4
Taiwan	74	44.9	91	55.1	45	27.3	16	9.7	104	63
China	81	55.1	66	44.9	37	25.2	1	0.68	109	74.2
Mexico	67	46.2	78	53.8	49	33.8	1	0.69	95	65.5
Poland	94	67.1	46	32.9	23	16.4	3	2.1	114	81.4
Portugal	54	44.6	67	55.4	32	26.4	1	0.8	88	72.7
Philippines	34	58.6	24	41.4	11	19	3	5.2	44	75.9
All civil-law countries	***1,454***	***58.1***	***1,048***	***41.9***	***634***	***25.3***	***100***	***4***	***1,768***	***70.7***

Table 3 continued

	Target origin				Organization form of the target					
	National		Cross border		public		private		sub	
Country	N	%	N	%	N	%	N	%	N	%
Panel A: Acquirers from common-law countries										
Malaysia	576	79	154	21	96	13	400	55	234	32
India	243	49	250	51	92	19	233	47	168	34
South Africa	257	60	170	40	125	29	164	38	138	32
Hong Kong	181	48	200	53	108	28	136	36	137	36
Singapore	191	49	198	51	58	15	168	43	163	42
New Zealand	117	52	108	48	51	23	118	52	56	25
All Common-law countries	***1,565***	***59***	***1,080***	***41***	***530***	***20***	***1,219***	***46***	***896***	***34***
Panel B: Acquirers from civil-law countries										
South Korea	473	82	106	18	179	31	315	54	85	15
Norway	223	41	325	59	103	19	275	50	170	31
Greece	140	60	94	40	38	16	142	61	54	23
Brazil	130	69	58	31	42	22	77	41	69	37
Russia	122	69	55	31	23	13	90	51	64	36
Taiwan	103	62	62	38	55	33	53	32	57	35
China	126	86	21	14	17	12	56	38	74	50
Mexico	64	44	81	56	40	28	42	29	63	43
Poland	115	82	25	18	28	20	68	49	44	31
Portugal	62	51	59	49	29	24	48	40	44	36
Philippines	46	79	12	21	16	28	21	36	21	36
All civil-law countries	***1,604***	***64***	***898***	***36***	***570***	***23***	***1,187***	***47***	***745***	***30***

3.2. Announcement Abnormal Return:

This study analyzes the performance of repeated acquirers (i.e. the market reaction to acquirers' announcements) by using the event study method. To calculate the daily abnormal return around the merger announcement, the study uses the modified market-adjusted model, which subtracts the daily market return from the daily return of each firm (Antoniou ,Petmezas, and Zhao, 2007; Dong, Hirshleifer, Richardson, and Toeh, 2005; Fuller, Netter, and Stegemoller, 2002 among other).

$$AR_{it} = R_{it} - R_{mt} \quad (1)$$

Where AR_{it} is the abnormal return of firm i on day t, R_{it} is the return of firm i on day t, R_{mt} is the value weighted market index return. Next, the calculation of the daily abnormal return is used to calculate the cumulative abnormal returns (CARs) for the five-day period (-2, 2) around the announcement of a merger deal as follows:

$$CAR_{i(-2,2)} = \sum_{t=-2}^{t=2} AR_{it} \quad (2)$$

The study assesses the pattern of the CARs for repeated acquirers from common and civil-law countries as well as the individual countries in both groups. After highlighting the CARs' pattern, the study further investigates various factors that might explain the reported pattern using both univariate and multivariate framework.

4. Empirical Results:

4.1. CARs Trend:

4.1.1. Univariate Analysis:

To examine the market reaction to acquirers' announcements of repeated acquisitions in emerging countries, a univariate analysis investigates the impact of deal order on acquisition performance for repeated acquirers from common and civil-law countries. The results are shown in Table 4. The CARs are positive for repeated acquirers from common-law countries regardless of deals' order, but the CARs decline over the deals' order series. In other words, the CARs are declining as acquirers are involved in more mergers and acquisitions. In Table 4 Panel A, I report the CARs for the full sample of repeated acquirers from common-law countries as well as the individual countries of that group. For all bids reported in common-law countries, the CARs on the first deal order (1^{st} deal hereafter) declines from a significantly positive of 2.03% (t = 5.16) to significantly positive of 1.11% (t = 5.15) for the 2^{nd}&3^{rd} deals and then to 1.03% (t = 3.93) for the 4^{th} and higher deal order. The decline in CARs between the first deal and beyond the third deal is significant at the 5% level, and it is also significant between the first and the 2^{nd}&3^{rd} deals at the 5% level. Moreover, the declining trend in CARs of repeated acquirers also holds for common-law countries when considering the simple mean of the CARs for all countries in the sample (using equal weight for each country). Specifically, the CARs on the 1^{st} deal order declines from 2.45% (t=5.15) to 1.17% (t=5.4) for the 2^{nd}&3^{rd} deals and then to 1.01% (t=5.2) for 4^{th} and higher order.

The same pattern is also seen for each individual country. For example, for the Indian frequent acquirers, the CARs on the 1^{st} deal order decline from a significantly positive of 2.65% (t = 3.85) for the 1^{st} deal to a significantly positive of 1.06% (t = 2.30) for deals beyond the 3^{rd} deal. The decline in CARs is significant at the 1% level between the 1^{st} deal and beyond the 3^{rd} deal, and it is also significant at the 5% level between the 1^{st} and the 2^{nd}&3^{rd} deals.

In Table 4 Panel B, I report the CARs for the full sample of repeated acquirers from civil-law countries as well as the individual countries of that group. Similar results, some even more dramatic, are reported for all bids in civil-law countries. The CARs on first deal order declines noticeably from a significantly positive of 2.11% (t = 4.79) to significantly positive of 0.88% (t = 3.54) for the 2nd&3rd deals and then lower to 0.17% (t = 0.84) for the 4th deal and more. Decline in CARs between the 2nd&3rd deals and beyond the 3rd deal is statistically significant at the 5% level. The decline between the 1st and the 2nd&3rd deals as well as the 1st deal and beyond 3rd deals is also significant at the 1% level. Further, the CARs trend also holds for civil-law countries when I consider the simple average of the CARs of all countries (i.e. equal weight for each country). The CARs on the first deal declines from 1.87% (t = 3.81) to 0.83% (t = 4.64) for the 2nd&3rd deals and then to 0.017% (t = 0.09) for 4th and higher order.

The same pattern of declining returns is also found for each individual country of civil-law group. For instance, the frequent acquirers from Norway experience a strong pattern of declining CARs; the CARs on first deal order declines from a significantly positive of 2.84% (t = 3.38) to significantly positive of 0.51% (t = 1.66) for deals beyond the 3rd deal. The decline is significant in CARs between the 1st deal and beyond 3rd deals at the 5% level. It is also significant between the 2nd&3rd deals and deals beyond the 3rd deal at the 10%. Furthermore, frequent acquirers from some civil-law countries (South Korea, Poland, Philippines, Mexico, and Greece) even experience negative CARs for deals beyond the 3rd deal. For example, acquirers from Poland exhibit a strong declining trend in CARs; the CARs on first deal order decline from a significantly positive of 5.47% (t = 1.84) to -0.28% (t = -0.48) for the deals beyond the 3rd deal. The decline in CARs between the 1st deal and beyond 3rd deals is significant at the 5% level, and it is also significant between the 1st and the 2nd&3rd deals at the 5% level.

Table 4
Cumulative Abnormal Returns (CARs) for Frequent Acquirers by Deal Order

This table presents the acquisitions performance of a frequent acquirer by deal order. Frequent acquirer is a public firm if it acquires at least two targets within any five-year horizon over the sample period. Deal order is based on a rolling 5-year window. CARs for bidders are calculated for the five-day period (-2, 2) around the announcement (day 0) of a merger deal. Daily abnormal return around the merger announcement is measured using a modified market-adjusted model:

$$AR_{it} = R_{it} - R_{mt}$$

Where R_{it} is the return of firm i on day t, R_{mt} is the value weighted market index return. Panels A and B contain CARs for the frequent acquirers from common and civil-law countries, respectively. Each panel reports the CARs for the 1st bid, 2nd&3rd, and beyond 3rd deals of the frequent acquirers for each country. The last two rows of each panel report the simple average of CARs of all countries and for the cross-country average (each country is equally weighted). The difference between the CARs for different categories: (1st - >3rd), (1st -2nd&3rd), and (2nd&3rd - >3rd) are calculated. A t-test is used to test if the mean of these differences is different than zero. Number in parentheses indicates t-statistics. a, b and c refer to significance at the 1,5,10% levels respectively.

Country	Deal order			Differences tests		
	1st (1)	2nd - 3rd (2)	>3rd (3)	(1) – (2)	(1) – (3)	(2) – (3)
Panel A: Common-law countries						
Malaysia	0.964	0.653	0.166	0.311	0.799	0.488
	[2.158]b	[1.886]c	[0.303]	[0.537]	[1.102]	[0.689]
India	2.650	1.032	1.063	1.617	1.586	-0.031
	[3.845]a	[2.649]a	[2.298]b	[2.205]b	[1.975]a	[-0.052]
South Africa	2.637	1.390	1.596	1.247	1.041	-0.206
	[2.693]a	[2.056]b	[2.697]a	[1.060]	[0.967]	[-0.223]
Hong Kong	2.355	1.898	0.913	0.456	1.442	0.985
	[1.275]	[2.329]a	[1.175]	[0.261]	[0.799]	[0.850]
Singapore	1.674	1.511	1.080	0.163	0.594	0.430
	[1.963]c	[3.126]a	[1.201]	[0.179]	[0.458]	[0.455]
New Zealand	4.421	0.518	1.236	3.903	3.185	-0.718
	[2.106]b	[0.736]	[2.777]a	[2.179]b	[2.104]b	[-0.894]
All common-law countries	**2.038**	**1.115**	**1.031**	**0.923**	**1.007**	**0.084**
	[5.161]a	[5.149]a	[3.928]a	[2.230]b	[2.185]b	[0.244]
Cross country average	**2.450**	**1.167**	**1.009**	**1.283**	**1.441**	**0.158**
	[5.154]a	[5.390]a	[5.213]a	[2.238]c	[3.783]b	[0.645]
Panel B: Civil-law countries						
South Korea	2.958	0.488	-0.253	2.469	3.211	0.741
	[3.191]a	[0.908]	[-0.373]	[2.473]b	[2.396]b	[0.728]
Norway	2.840	1.552	0.512	1.287	2.327	1.040
	[3.375]a	[3.072]a	[1.659]c	[1.340]	[3.035]b	[1.857]c
Greece	1.170	1.054	-0.401	0.115	1.571	1.455
	[1.189]	[0.863]	[-0.246]	[0.063]	[0.753]	[0.729]
Brazil	2.299	0.655	0.092	1.644	2.208	0.563
	[1.037]	[1.175]	[0.142]	[0.896]	[1.215]	[0.650]
Russia	1.300	1.530	0.682	-0.229	0.617	0.847
	[0.840]	[1.927]c	[2.016]b	[-0.142]	[0.5612]	[1.145]
Taiwan	0.759	0.693	0.271	0.066	0.488	0.422
	[0.911]	[1.163]	[0.371]	[0.066]	[0.423]	[0.431]
China	-1.053	1.729	0.864	-2.782	-1.917	0.865
	[-1.120]	[1.973]c	[0.625]	[-2.015]b	[-1.153]	[0.463]
Mexico	1.345	0.789	-0.603	0.556	1.948	1.391
	[0.517]	[1.049]	[-1.000]	[0.269]	[1.101]	[1.428]

Table 4 continued

Country	Deal order			Differences tests		
	1st (1)	2nd - 3rd (2)	>3rd (3)	(1) – (2)	(1) – (3)	(2) – (3)
Poland	5.476	0.562	-0.286	4.915	5.762	0.848
	[1.836][c]	[0.730]	[-0.480]	[2.036][b]	[2.449][b]	[0.867]
Portugal	1.397	0.500	0.344	0.897	1.053	0.156
	[1.429]	[0.551]	[0.584]	[0.604]	[0.968]	[0.145]
Philippines	2.085	-0.339	-1.035	2.424	3.119	0.696
	[2.624][b]	[-0.407]	[-0.713]	[1.852][c]	[2.054][c]	[0.409]
All civil-law countries	**2.115**	**0.882**	**0.177**	**1.233**	**1.938**	**0.705**
	[4.789][a]	[3.538][a]	[0.846]	[2.623][a]	[4.460][a]	[2.140][b]
Cross country average	**1.870**	**0.837**	**0.017**	**1.033**	**1.853**	**0.821**
	[3.814][a]	[4.639][a]	[0.096]	[1.765][c]	[3.178][a]	[7.099][a]
Difference test						
Common-law **–** Civil-law	-0.077	0.233	0.853			
	[-0.131]	[-0.012]	[2.572][b]			

The CARs trend is also robust for common and civil-law countries regardless of the method of payment used. The results are shown in Table 5. For example, the CARs for repeated acquirers from civil-law countries decline from a significantly positive of 0.38% (t = 1.72) for the first deal to -0.08% (t = -0.55) for the 4th deal and more if the cash is used. Similar decline occurs even when stock payment is used (from a significantly positive of 0.34% (t = 2.2) for the 1st deal to significantly positive of 0.06% (t = 1.91) for the 4th or higher deals). In the common-law countries the CARs decline from a significantly positive of 0.68% (t = 4.4) for the 1st deal to significantly positive of 0.28% (t = 2.1) for the 4th deal and more if cash is used. CARs also decline from 0.24% (t = 1.91) for the 1st deal to 0.09% (t = 0.77) for the 4th deal and more if stock is used. Table 5 also reveals that cash payment results in higher positive abnormal returns than stock payment across the board in both common and civil-law countries. These findings are consistent with other studies (Agrawal, Jaff, and Mandelker, 1992; Franks, Harris, and Mayer 1988; and Fuller, Netter, and Stegemoller, 2002) who report that bidders who use non-cash methods of payment to buy a public firm perform worse than cash bidders. These results are also consistent with Myers and Mujluf (1984) in which the choice between cash and stock determines the bidder returns.

Table 5

Cumulative Abnormal Returns (CARs) of Frequent Acquirers by Deal Order and by Mode of Payment

This table presents the acquisitions performance for frequent acquirers. Each panel is divided by deal order and by the method of payment. Deal order is based on a rolling 5-year window. All cash includes transactions made only in cash, or cash and debt. All stock defined as transactions made only in common stock to pay for the acquisition. Mixed offer defined as a transaction made in cash and stock and/or convertibles, and method classified by SDC as "other".

Deal order	Mode of payment		
	All cash	All stock	Mixed
Panel A: Acquirer from common-law countries			
1st	0.678	0.237	1.123
	[4.400][a]	[1.914][c]	[3.284][a]
2nd – 3rd	0.337	0.136	0.642
	[2.882][a]	[1.631]	[3.959][a]
> 3rd	0.284	0.096	0.651
	[2.096][b]	[0.778]	[3.437][a]
Panel B: Acquirer from civil-law countries			
1st	0.388	0.339	1.388
	[1.724][c]	[2.156][b]	[4.027][a]
2nd – 3rd	0.264	0.139	0.479
	[1.839][c]	[2.554][b]	[2.441][b]
> 3rd	-0.078	0.064	0.192
	[-0.554]	[1.914][c]	[1.271]

To conclude the univariate results, the CARs decline, on average, from deal to deal for common and civil-law countries, though the CARs trend is almost flat for common-law countries (declines from 2.03% to 1.03%), and steep for civil-law countries (declines from 2.11% to 0.17%). That is to say, for higher order deals, the effect is more pronounced for civil-law counties than for common-law countries. The documented pattern of repeated acquirers in this study is consistent with the experience of repeated acquirers from the U.S. and the UK in having a decline returns for subsequent bids. The pattern of declining pattern is a real phenomenon for both developed and emerging countries, which is even more pronounced in civil-law countries. Additional details on why the declining returns are more pronounced for civil countries are given in section 4.2.

4.1.2. Multivariate Analysis:

To confirm the univariate results that the CARs pattern is declining in subsequent deals, the study uses multiple regression analysis to investigate the role of deal order on acquirer performance. Two cross-sectional regressions are estimated separately:

$$\text{CAR} = \alpha_o + \alpha_1 \text{deal order} + \varepsilon \tag{3}$$

$$\text{CAR} = \alpha_o + \alpha_1 \text{deal order} + X\beta + \varepsilon \tag{4}$$

Equation 3 is a simple regression of the five-day CARs on *deal order*. The expected sign of the *deal order* variable is negative (the CARs are declining as acquirers are involved in more mergers and acquisitions) due to agency problems and hubris behavior. Equation 4 is a multiple regression of CARs on *deal order* and a set of control variables "X" that are used in recent literature (Conn, Cosh, Guest, and Hughes (2004); Moeller, Schlingemann, and Stulz, 2004; Aktas, Bodt, and Roll, 2007b, Ismail, 2008; and Ahern, 2008) and represent acquirer, target, and deal characteristics. These variables include number of dummies: *Time between each* *acquisition* takes the value of one if the time between each acquisition is more than one year ; *Public* takes the value of one if a public firm is acquired; *Private* takes the value of one if a private firm is acquired; *Tender offer* takes the value of one if the acquisition is a tender offer; *Same industry* takes the value of one if the target and acquirer have the same three-digit SIC code; *Cash* takes the value of one if the transaction is made only in cash or cash and debt; *Cross border* takes the value of one if the target and the acquirer are not located in a same country; *Hostile* takes the value of one if it is hostile according to SDC; and *Compete* takes the value of one if there is more than one bidder. *Firm size* which is defined as the natural logarithm of the acquirer's total assets is also included.

Table 6 reports the results for the two regressions. The first column reports that the deal order in common-law countries affects negatively the CARs -0.15, and it is statistically significant at the 5% level. When I replace the deal order with the 2^{nd} deal and later deals (deal order > 3), the results remain negative and significant on the CARs. These results are consistent with the univariate results. However, controlling for other variables, the impact of the deal order is still negative but not statistically significant, which shows that the inclusion of a set of control variables affects the evidence of the univariate analysis for common-law countries. Among the control variables, only firm size has a significant coefficient at the 1% level. Firm size is negatively related to the acquirer's abnormal return and is consistent with other studies (Moeller, Schlingemann, and Stulz, 2004; Billett and Qian, 2005).

For the return regression of civil-law countries, the third column reports that the deal order coefficient is negative -0.18 and significant at the 1% level. Controlling for acquiring firm, target, and deal characteristics, the deal order is still significantly and negatively affect CARs (i.e. the deal order effect still holds even with the control variables). The results of both regressions are consistent with the evidence provided by the univariate analysis that the CARs decline with deal order. Among the control variables, the study finds that the acquirer's abnormal return is significantly larger at the 10% level when buying a private firm which is consistent with other studies (e.g. Fuller, Netter, and Stegemoller, 2002; Moeller, Schlingemann, and Stulz, 2004).

Table 6
CARs by Deal Order- Results of the Multivariate Analysis

The table summarizes the results of regressing the five-day (CARs) on deal order and a set of control variables. Column one and four present the results for a simple regression of CARs on deal order for common and civil-law countries, respectively. Column three and six present the results of a multiple regression of CARs on deal order and a set of control variables for common and civil-law countries, respectively. Column two and five represent the results of CARs on the second deal, third deal and beyond 3[rd] deals for common and civil-law countries, respectively. The control variables include a number of dummy variables: *Time between each acquisition* takes the value of one if the time between each acquisition is more than one year ; *Public* takes the value of one if a public firm is acquired; *Private* takes the value of one if a private firm is acquired; *Tender offer* takes the value of one if the acquisition is a tender offer; *Same industry* takes the value of one if the target and acquirer have the same three-digit SIC code; *Cash* takes the value of one if the transaction is made only in cash or cash and debt; *Cross border* takes the value of one if the target and the acquirer are not located in a same country; *Hostile* takes the value of one if it is hostile according to SDC; and *Compete* takes the value of one if there is more than one bidder. *Firm size* is defined as the natural logarithm of the acquirer's total assets. a, b and c refer to significance at the 1,5, 10% levels respectively.

Dependent variable:	Acquirer from common-law countries			Acquirer from civil-law countries		
$CARs_{(-2,+2)}$	(1)	(2)	(3)	(4)	(5)	(6)
Acquirer characteristic						
Deal order	-0.155		-0.049	-0.176		-0.156
	[-2.06][b]		[-0.59]	[-3.57][a]		[-2.65][a]
Second		-0.964			-1.015	
		[-2.21][b]			[-2.18][b]	
Third		-0.853			-1.615	
		[-1.71][c]			[-2.99][a]	
> third		-1.007			-1.938	
		[-2.30][b]			[-4.47][a]	
Firm size			-0.438			-0.112
			[-4.12][a]			[-1.23]
Time between each			0.182			-0.631
acquisition			[0.53]			[-1.27]
Target characteristic						
Public			-0.398			-0.184
			[-0.78]			[-0.34]
Private			-0.367			0.712
			[-0.97]			[1.73][c]
Deal characteristic						
Tender offer			1.041			0.259
			[1.07]			[0.25]
Same industry			-0.076			0.117
			[-0.22]			[0.33]
Cash			0.208			-0.236
			[0.55]			[-0.54]
Cross border			0.527			-0.124
			[1.53]			[-0.33]
Hostile			-2.095			-3.857
			[-0.52]			[-0.45]
Compete			0.534			0.935
			[0.19]			[0.26]
Constant	1.774	2.038	3.708	1.556	2.115	2.303
	[6.47][a]	[6.31][a]	[5.28][a]	[6.30]	[6.13][a]	[3.10][a]
R^2	0.001	0.002	0.011	0.005	0.008	0.011
N	2645	2645	2229	2502	2502	2018

4.2. What are the Driving Forces for a Declining Trend in CARs?

4.2.1. The Effect of the Successful First Time Acquirer

Conn, Cosh, Guest, and Hughes (2004) link declining returns of repeated acquirers to the hubris hypothesis and report that the decline in returns occurs only for the successful first time acquirers. Hayward and Hambrick (1997) report that recent firm success fosters the hubris behavior.

I follow Conn, Cosh, Guest, and Hughes (2004)'s approach by examining whether the link between the declining returns of repeated acquirers and hubris behavior is present in common and civil-law countries. Two cross-sectional regressions are estimated separately, in which the dependent variable is the five-day CARs:

$$\text{CAR} = \alpha_o + \alpha_1 \text{successful} + \alpha_2 (\text{deal order} \times \textit{successfuldummy}) + \varepsilon \qquad (5)$$

$$\text{CAR} = \alpha_o + \alpha_1 \text{successful} + \alpha_2 (\text{deal order} \times \textit{successfuldummy}) + X\beta + \varepsilon \qquad (6)$$

The first regression described in equation 5 follows Conn, Cosh, Guest, and Hughes (2004) by introducing two dummies; the *successful* first acquisition (the frequent acquirer with a positive market reaction for the first deals), and the interaction term formed by multiplying the *deal order* by the *successful dummy* (*deal order*×*successful dummy*). The *successful* dummy takes the value of one if the first acquisition is successful, whereas the interaction term takes the value of the *deal order*, if the *successful* dummy is equal to one. The interaction of the *deal order* variable with the *successful* dummy measures the incremental impact of deal order on abnormal returns for the acquirers with first successful acquisition over the unsuccessful first acquisition. The expected sign of the *successful* dummy is positive, while the interaction term is negative because the first time success leads to overconfidence, which results in a declining performance of the subsequent deals. The second regression described in equation 6 repeats equation 5 but controls for a set of control variables " X " (Conn, Cosh, Guest, and Hughes, 2004; Moeller, Schlingemann, and Stulz, 2004; Aktas, Bodt, and Roll, 2007b; Ismail, 2008; and Ahern, 2008). " X " variables are similar to the ones that are already used in equation 4.

The regression results in the first column entitled "acquirer from common-law countries" and the third column entitled "acquirer from civil-law countries" of Table 7 indicate that the acquirers from common and civil-law countries with a successful first acquisition have a significant positive effect on CARs. The coefficients of the *successful* dummy are positive and significant at the l% level for the acquirers from common countries and civil-law countries 5.32, 6.25 respectively. This suggests that the acquirer from civil-law countries who succeeds at first acquisition earns 625 basis points more than the acquirer who does not succeed at first acquisition. In contrast, the interaction term (*deal order*×*successful dummy*) coefficients are negative and significant at the 1% level for acquirers from common and civil-law countries -0.716, -1.083, respectively. The significant interaction coefficient suggests that the subsequent performance of acquirers who make successful first acquisition experience a decline rather than the improvement experienced by the unsuccessful first time acquirers (i.e. there is a significant difference in the impact of deal order on abnormal returns between the successful first time bidders and the unsuccessful first time acquirers). These findings are consistent with Conn, Cosh, Guest, and Hughes (2004).

The regression results in the second and the fourth column of Table 7 report the results of the multiple regression described in equation 6. The reported results indicate that the *successful* dummy and the interaction term remain unchanged either in their signs and significance. The coefficients of *successful* dummy are positive and significant at the 1% level of frequent acquirers for common and civil-law countries 4.49, 5.58 respectively. The interaction term coefficients of frequent acquirers from common -0.57 and civil-law countries -0.89 are significant at the 1% level. In other words, controlling for a variety of acquirer, target and deal characteristics does not change the result. Equations 6 and 7 are estimated for each individual country from both groups (not reported) and the results do not change qualitatively.

Among the control variables, the CARs for frequent acquirers from common-law countries are significantly affected by the *firm size* and the *cross border* dummy. The *firm size* has a significantly negative effect of -0.431 (t = -3.39) which is consistent with Moeller, Schlingemann, and Stulz (2004), and the abnormal return is larger and significant 0.618 (t = 1.83) from cross border M&As which also consistent with Fatemi and Furtado (1988); Morck and Yeung (1992); and Markides and Ittner (1994). In contrast, *firm size* is negatively affecting CARs for frequent acquirers from civil-law countries but it is not statistically significant. Buying a private firm by acquirers from civil-law countries affects positively and significantly 0.725 (t = 1.81) their abnormal return. These results are consistent with other studies (Fuller, Netter, and Stegemoller, 2002; Moeller, Schlingemann, and Stulz, 2004).

The study also controls for economic differences within each group of common and civil-law countries and the main findings do not change qualitatively. Specifically, I re-estimate equation 6 by adding a dummy variable that takes a value of one if the country is a high-income economy, based on the World Bank classifications, and a value of zero if the country is a middle-income economy. The coefficient of the dummy is positive but not statistically significant in both groups.

Table 7
Results of Multiple Regression of Acquisition Performance on Acquisition Characteristics

The table summarizes the results of the multivariate analysis. The dependent variable is the five-day Cumulative abnormal returns (CARs) measured using a modified market-adjusted model. The control variables include a number of dummy variables: *successful first acquisition* takes the value one if the first acquisition is successful; *deal order×successful dummy* takes the value of deal order if the dummy is equal to one; *Public* takes the value of one if the acquisition of public firms; *Private* takes the value of one if the acquisition of private firms, *Tender offer* takes the value of one if the acquisition is a tender offer; *Same industry* takes the value of one if the target and acquirer have the same three-digit SIC code; *Cash* takes the value of one if transaction made only in cash or cash and debt; *Cross border* takes the value of one if the target and acquirer are not located in a same country; *Hostile* takes the value of one if it is hostile according to SDC; and *Compete* takes the value of one if there is more than one bidder. I also include *firm size* which is defined as the natural logarithm of the acquirer total assets. a, b and c refer to significance at the 1,5, 10% levels respectively.

Dependent variable: $CARs_{(-2,+2)}$	Acquirer from common-law countries		Acquirer from civil-law countries	
	(1)	(2)	(3)	(4)
Acquirer characteristics				
Successful 1st acquisition	5.323	4.498	6.254	5.581
	[12.42][a]	[9.84][a]	[13.20][a]	[10.50][a]
(deal order*successful 1st acquisition)	-0.716	-0.577	-1.083	-0.895
	[-6.87][a]	[-5.33][a]	[-8.48][a]	[-6.48][a]
Firm size		-0.431		-0.034
		[-3.39][a]		[-0.39]
Panel B: Target characteristic				
Public		-0.431		-0.255
		[-0.87]		[-0.49]
Private		-0.360		0.725
		[-0.98]		[1.81][c]
Panel C: Deal characteristics				
Tender offer		1.292		0.572
		[1.36]		[0.56]
Same industry		-0.050		0.099
		[-0.15]		[0.29]
Cash		0.137		-0.196
		[0.37]		[-0.46]
Cross border		0.618		-0.032
		[1.83][c]		[-0.09]
Hostile		-2.588		-2.170
		[-0.66]		[-0.26]
compete		0.512		1.048
		[0.19]		[0.30]
constant	-0.092	1.87	-0.326	-0.345
	[-0.45]	[2.78]	[-1.67][c]	[-0.48]
R^2	0.057	0.054	0.066	0.061
n	2645	2229	2502	2018

The findings from Table 7 collectively suggest that there is a significant link between the declining returns of repeated acquirers and hubris behavior for common and civil-law countries, yet it is more pronounced in civil-law countries if we consider the larger negative impact of the later deals on CARs in civil-law countries, which is captured by the interaction term (*deal order* ×*successful dummy*) in equation 6, compared to common-law countries. One possible explanation is that firms in common-law countries have more outside directors and operate in an environment where the shareholder is well protected. This suggests that board characteristics in common-law countries are more likely to resist major acquisitions' proposals by a CEO with hubris behavior.

To further confirm the findings, I inspects whether the declining return is more pronounced for acquirers whose first acquisitions is successful. Stated differently, the study examines whether the performance of successful time acquirers underperform as they go towards the end of the deal order series. Table 8 shows the results of the CARs' trend for the successful first time acquirers are presented.

The results in Table 8 Panel A, reveal that the CARs, for repeated acquirers from common-law countries with a successful first acquisition, exhibit a declining trend from a significantly positive of 7.062% (t = 13.68) for first deal to significantly positive of 1.512% (t = 4.35) for the 2^{nd}&3^{rd} deals, and slightly lower to significantly positive of 1.158% (t = 3.19) for the 4^{th} deal and greater. Decline in CARs between the 1^{st} deal and beyond 3^{rd} deal 5.904 (=7.062 - 1.158) is significant at the 1% level. The same pattern is also seen for each individual country. For example, South African frequent acquirers experience a pattern of declining CARs; the CARs on first deal order decline from a significantly positive of 6.67% (t = 5.54) to significantly positive of 1.7% (2.19) for deals beyond the 3rd deal. Decline in CARs between the 1st deal and beyond 3rd deals 6.991(= 7.378 - 0.388) is significant at the 1% level.

The results in Table 8, Panel B, show that for repeated acquirers from civil-law countries with a successful first acquisition, the CARs exhibit a noticeably declining trend compared to that of common-law countries. The CARs decline from a significantly positive of 7.37% (t = 11.63) for first deal to 0.38% (t = 0.99) for the 4th deal and greater. Decline in CARs between the 1st deal and beyond the 3rd deal is significant at the 1% level. The same pattern is also found for each individual country. For example, South Korean frequent acquirers experience a strong pattern of declining CARs; the CARs on first deal order declines from a significantly positive of 9.7% (t = 7.57) to -1.27% (t = -1.07) for deals beyond the 3rd deal. Decline in CARs between the 1st deal and beyond 3rd deals is significant at the 1% level.

The findings from Table 8 collectively suggest that the declining return for successful first acquisitions is more pronounced in civil-law countries. This finding is consistent with the multivariate analysis result that there is a link between the declining returns of repeated acquirers and hubris behavior.

In sum, these findings indicate hubris behavior and are consistent with overconfidence. That is to say, the first time success promotes hubris which, in turn, produces a declining performance of subsequent deals. One Possible explanation for these results is that those successful first bidders pay a higher premium with bid order. This explanation is discussed and tested below for common and civil-law countries.

Table 8
Cumulative Abnormal Returns for Successful First Time Acquirers by Deal Order

This table presents the acquisitions performance by deal order for first successful frequent acquirers. Frequent acquirer is a public firm if it acquires at least two targets within any five-year horizon. Deal order is defined based on a rolling 5-year window (i.e. if the firm acquired one acquisition within the last five year history, then the current deal order is two). Successful first acquisition defined as a frequent acquirer with a positive market reaction for the first deals, CARs for the five-day period (-2, 2) around the announcement are measured using a modified market-adjusted model. Panel A and B contain the calculated CARs for the successful first time acquirers from common and civil-law countries by deal order (1st bid, 2nd - 3rd, and beyond 3rd), respectively. I calculate the difference between the CARs for the first deal and beyond the third deal (1st - >3rd) and report the mean of this difference. A t-test is used to test whether the mean of this difference is different than zero. Number in parentheses indicates t-statistics. a, b and c refer to significance at the 1,5, 10% levels respectively.

Acquirer origin	Deal order			Difference tests
	1st	2nd – 3rd	>3rd	
	(1)	(2)	(3)	(1) – (3)
Panel A: Acquirers from common-law countries				
Malaysia	5.395	2.076	-0.901	6.297
	[9.646][a]	[3.235][a]	[-0.911]	[5.391][a]
India	7.183	0.772	1.245	5.937
	[9.991][a]	[1.545]	[2.115][b]	[6.404][a]
South Africa	6.670	2.018	1.727	4.942
	[5.542][a]	[2.024][b]	[2.189][b]	[3.466][a]
Hong Kong	10.770	1.232	1.064	9.706
	[4.056][a]	[0.903]	[0.822]	[3.089][a]
Singapore	6.448	1.917	0.727	5.720
	[6.616] [a]	[2.276][b]	[0.562]	[3.392][a]
New Zealand	8.614	0.335	1.885	6.729
	[3.632][a]	[0.260]	[2.475][b]	[3.232][a]
Common-law countries	***7.062***	***1.512***	***1.158***	***5.904***
	[13.676][a]	**[4.354][a]**	**[3.191][a]**	**[8.799][a]**
Panel B: Acquires from civil-law countries				
South Korea	9.706	0.676	-1.272	10.979
	[7.568][a]	[0.762]	[-1.071]	[4.503][a]
Norway	6.687	2.254	1.833	4.855
	[7.412][a]	[2.968][a]	[2.009][c]	[3.783][a]
Greece	6.129	3.378	1.746	4.384
	[4.744][a]	[2.695][b]	[0.974]	[2.016][b]
Brazil	7.688	1.412	-0.376	8.063
	[2.118][b]	[1.937][c]	[-0.599]	[3.251][a]
Russia	5.073	1.775	-1.052	6.125
	[3.554][a]	[1.113]	[-0.999]	[3.271][a]
Taiwan	4.580	0.004	0.364	4.215
	[5.134][a]	[0.004]	[0.229]	[2.416][b]
China	4.099	2.847	4.056	0.042
	[4.413][a]	[1.877][c]	[2.100][c]	[0.022]
Mexico	8.135	-1.213	0.603	7.532
	[1.548]	[-0.672]	[0.405]	[1.652]
Poland	11.865	-0.457	-0.487	12.352
	[2.506][b]	[-0.606]	[-0.286]	[1.944][c]
Portugal	4.309	1.038	-0.555	4.863
	[3.840][a]	[0.548]	[-0.678]	[3.579][a]
Philippines	3.311	-1.906	NA	NA
	[4.617][a]	[-1.245]		
Civil –law countries	**7.378**	**1.170**	**0.388**	**6.991**
	[11.630][a]	**[3.055][a]**	**[0.996]**	**[8.668][a]**

4.2.2. Pattern in Merger Premium:

The hubris hypothesis predicts that early success leads to managerial overconfidence and overpays in subsequent deals (Hayward and Hambrick, 1997; Conn, Cosh, Guest, and Hughes, 2004; Aktas, Bodt, and Roll, 2007b). To test for hubris hypothesis prediction, this study investigates whether the premium paid by an acquirer for a public target increases with a deal order when the first acquisition is successful. Based on the relationship between the degree of investor protection in a given country and the performance of acquirers from emerging markets, the premiums paid by a frequent acquirer in common-law country with a successful first acquisition is likely to be less than that by an acquirer in a civil-law country. The difference in the premium paid for acquisitions between the acquirers from the common and civil-law countries is due to the lack of sufficient institutional governance infrastructure (e.g. laws and regulations) in civil-law countries.

To examine the hubris hypothesis, two cross-sectional regressions are estimated separately in which the premium paid to target (only available for a public firm) is the dependent variable:

$$\text{Premium} = \alpha_o + \alpha_1 \text{deal order} + \varepsilon \qquad (7)$$

$$\text{Premium} = \alpha_o + \alpha_1 \text{deal order} + X\beta + \varepsilon \qquad (8)$$

The first model described in equation 7 is a simple regression of the acquirer premium for the first successful acquisition on deal order. The premium is calculated as the transaction value, as reported by SDC, divided by the market value of the target four weeks prior to the announcement date (Moeller, Schlingemann, and Stulz, 2004).

The second model described in equation 8 is a multiple regression of the premium on the deal order and a set of control variables. The control variables include deal characteristics with the same specifications as in the recent studies (e.g. Moeller, Schlingemann, and Stulz, 2004). "*X*" reflects a number of dummy variables in equation 8: *Same industry* takes the value of one if the target and acquirer have the same three-digit SIC code; *Cash* takes the value of one if transaction made only in cash or cash and debt; *Tender offer* takes the value of one if the acquisition is a tender offer; *Hostile* takes the value of one if it is hostile according to SDC; and *Compete* takes the value of one if there is more than one bidder. Other independent variables include *deal order*, $Ln(equity_{bidder})$, and $Ln(equity_{target})$. $Ln(equity_{bidder})$ is the natural logarithm of the acquirer market equity four weeks prior to the announcement date. $Ln(equity_{target})$ is the natural logarithm of the target market equity four weeks prior to the announcement date. The natural logarithm is used to capture any variation in firm size. Table 9 reports the results for the two regressions.

The regression analysis in the first column and the third column of Table 9 reports the results of the equation 7. These results indicate that the premium increases with bid order for the first successful time acquirers for common and civil-law countries. The coefficients of the deal order for first successful time acquirers are positive and significant for both groups. However, the coefficient for civil-law countries 2.536 is significantly higher than that of common-law countries 0.084 at the 5% level. This suggests that the premium paid by an acquirer in a common-law country is less than that in a civil-law country. These results are consistent with hubris hypothesis that the successful first bidders pay a higher premium with bid order.

After repeating the estimation of equation 7 with a set of control variables, the coefficient of the deal order for acquirers from civil-law countries remains positive and significant 2.91 at the 10% level. In contrast, the correspondent coefficient for acquirers from common-law countries is positive 0.05 but it not significant (t = 0.83). The mean difference between the coefficients 2.864 (= 2.916 - 0.052) is significant at the 10% level even after controlling for a different set of variables used in prior studies. These results are consistent with hubris hypothesis that the premium paid by civil-law countries' acquirers is higher than that of common-law acquirers. The control variables have the same impact on premium that is consistent with prior studies (Moeller, Schlingemann, and Stulz, 2004). The CARs for frequent acquirers from common-law countries is significantly affected by $Ln(equity_{bidder})$, $Ln(equity_{target})$, and the *tender offer*. $Ln(equity_{bidder})$ has a significant positive effect 0.223 (t = 2.08), and acquirer's abnormal return is larger 0.813 (t = 1.94) if the form of acquisition is a tender offer. Moreover, the $Ln(equity_{target})$ has a significant negative effect on CARs for frequent acquirers from common-law countries with -019 (t = -1.69) and civil-law countries with -6.963 (t = -3.53) since large targets are difficult to integrate them into acquirer's activities. The negative coefficient on $Ln(equity_{target})$ supports the previous evidence by Moeller, Schlingemann, and Stulz (2004).

Table 9

Multivariate Analysis: Regressions of Bidder Premium for the First Successful Acquisition on Deal Order

The table summarizes the results of the multivariate analysis. The dependent variable is the bidder premium for the first successful acquisition. Premium paid to target (only available for public firm) is calculated as the transaction value, as reported by SDC, divided by the market value of the target 4 weeks prior to the announcement date. The independent variables include a number of dummy variables: *Same industry* takes the value of one if the target and acquirer have the same three-digit SIC code; *Cash* takes the value of one if transaction made only in cash or cash and debt; *Tender offer* takes the value of one if the acquisition is a tender offer; *Hostile* takes the value of one if it is hostile according to SDC; and *Compete* takes the value of one if there is more than one bidder. Other independent variables include *deal order*, $Ln(equity_{bidder})$, and $Ln(equity_{target})$. *Deal order* is defined based on a rolling 5-year window (i.e. if the firm acquired one acquisition within the last five year history, then the current deal order is two). $Ln(equity_{bidder})$ is the natural logarithm of the acquirer market equity four weeks prior to the announcement date. $Ln(equity_{target})$ is the natural logarithm of the target market equity four weeks prior to the announcement date. For each variable, I calculate the difference (Column1 – Column3) and (Column2- Column4) and report the mean of these differences. A t-test is used to test whether the mean of these differences is different than zero. a, b and c refer to significance at the 1,5,10% levels respectively.

Dependent variable:	Acquirers from common-law countries		Acquirers from civil-law countries		Difference tests	
premium	(1)	(2)	(3)	(4)	(1) – (3)	(2) – (4)
Deal order	0.0846	0.052	2.536	2.916	-2.451	-2.863
	[1.97][b]	[0.83]	[2.39][b]	[1.70]c	[-2.37][b]	[-1.76][c]
Ln ($equity_{bidder}$)		0.223		2.872		-2.648
		[2.08][b]		[1.19]		[-1.05]
Ln ($equity_{target}$)		-0.190		-6.963		6.773
		[-1.69][c]		[-3.53][a]		[2.86][a]
Same industry		0.210		7.133		-6.922
		[0.54]		[0.92]		[-0.81]
Cash		-0.139		-8.851		8.712
		[-0.38]		[-1.16]		[1.05]
Tender offer		0.813		2.733		-1.920
		[1.94][c]		[0.22]		[-0.17]
Hostile		-0.506		1.930		-2.253
		[-0.32]		[0.05]		[-0.06]
Compete		0.184				
		[0.23]				
Constant	0.411	-0.174	-4.201	17.171		
	[2.12][b]	[-0.23]	[-1.02]	[1.25]		
R^2	0.028	0.144	0.042	0.196		
n	133	85	134	92		

4.2.3. Time Interval between Successive Acquisitions:

Up to this point, I provide evidence that that premium paid to target increases with deal order for both civil and common-law countries, though the premiums paid by acquirers from civil-law countries with first successful acquisition are higher than those from common-law countries. These findings are consistent with hubris hypothesis predictions.

The hubris hypothesis also predicts that the returns decline the shorter the time between each acquisition (Fuller, Netter, and Stegemoller, 2002; Conn, Cosh, Guest, and Hughes, 2004; Aktas, Bodt, and Roll, 2007b). The probability of success in integrating subsequent acquisitions declines when the interval declines between successive acquisitions. To examine if the sample data is consistent with this prediction, the study calculates the time interval between subsequent acquisitions as the frequent acquirers with a first successful acquisition approach the end of the deal series. The results in Table 10 reveal that the interval between successive acquisitions for frequent acquirers declines over the deal series in both common and civil-law countries. In common-law countries, the mean time interval between two deals declines from 26.9 months (between the first and second acquisition) to 10 months (for the ninth acquisitions and more). In contrast, the mean time interval for civil-law countries goes from 19.2 months (between the first and second acquisition) to 8.9 months (for the ninth acquisitions and more). The frequent acquirers, toward the end of the deal series, are making deals faster than at the beginning of the series. This finding is consistent with the hubris prediction hypothesis in both groups. Furthermore, the time interval between the first and the second acquisition for civil-law countries is less than that for common-law countries (26.9 months vs. 19.2 months) which may indicate that the hubris behavior is higher even among frequent acquirers in civil-law countries at the beginning of the deal series.

Table 10 also shows that the acquisitions carried out with more than one year from the previous acquisition are declining with the number of deals in both common and civil-law countries. For acquirers from common-law countries, the percentage of acquisitions that carried out with more than twelve months declines from 69.5% for the first and second acquisition to 36.5% for the 9th acquisition and more. Whereas, the corresponding percentage in civil-law countries declines from 55.9% for the first and second acquisition to 29.5% for the 9th acquisition and more. This implies that the acquirers from civil-law countries, motivated by greater hubris than in common-law countries tend to acquire in a shorter period of time in later deals. Therefore, the abnormal returns for the common-law countries are more positive than that of civil-law countries.

Table 10
Time between Subsequent Acquisitions by Number of Deals: TBA Pattern

This table presents the time interval between successive acquisitions for frequent acquirers in common and civil-law countries. Column (1) refers to the number of days between two subsequent deals. Column (2) refers to the number of months between two subsequent deals. Column (3) refers to percentage of acquisitions that carried out with more than twelve months from previous acquisition by deal number.

Number of deals	Panel A: Acquirer from common-law countries			Panel B: Acquirer from civil-law countries		
	Days (1)	Months (2)	% of acquisition carried out with more than twelve months (3)	Days (4)	Months (5)	% of acquisition carried out with more than twelve months (6)
1st - 2nd	806.7	26.9	69.5	578.4	19.2	55.9
2nd - 3rd	879.5	29.3	67.4	648.9	21.6	55.3
3rd - 4th	598.1	19.9	58.2	502.8	16.7	50.0
4th - 5th	630.5	21	60.5	422.2	14.1	50.8
5th - 6th	376.7	12.5	42.1	373.7	12.4	51.4
6th - 7th	308.6	10.3	43.2	398.8	13.3	46.7
7th - 8th	397.3	13.2	48.0	220.1	7.3	52.4
8th - 9th	329.0	11	50.0	392.9	13	60.0
9th - >10th	301.3	10.0	36.5	267.5	8.9	29.5

5. Conclusion:

The study aims at examining the market reaction to acquirers' announcements of repeated acquisitions in emerging countries and analyzing whether agency problems and the hubris explanation can explain the cross-country variations in cumulative abnormal returns experienced by frequent acquirers. I hypothesize that the agency problems and hubris behavior are more pronounced for a civil-law acquirer than a common-law acquirer.

The cross section analysis of a sample of frequent acquirers from 17 common and civil-law countries shows that the CARs decline from deal to deal, though the CARs trend is almost flat for common-law countries, and steep for civil-law countries. This observation suggests that the value destructive to acquiring firms from civil-law counties in higher order deals is more pronounced than those from common-law countries.

The study further investigates whether the declining trend in CARs is a sign of hubris with subsequent deals by examining the performance of successful time acquirers from common and civil-law countries as they go towards the end of deal order series. The study finds that the decline in the subsequent performance of the acquirers from civil-law countries is more pronounced than acquirers from common-law countries because the premiums paid by a firm in a common-law country are less than the premiums paid by an acquirer in a civil-law country. The premium paid for acquisitions in the civil-law countries might be larger than those in common-law countries due to the lack of sufficient institutional governance infrastructure in emerging countries.

The study also finds evidence that the acquirers from civil-law countries, motivated by hubris, in relative to common-law countries tend to acquire in a short period of time in later deals. Therefore, the abnormal returns for the common-law countries are more positive than that of civil-law countries.

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Chapter 2
Analyzing Information Linkage across Futures Markets

1. Introduction:

Prior studies analyze the interaction among futures markets by examining the information transmission across commodity markets. Their empirical investigation focuses on the relation of return and volatility across markets. However, most of these studies analyze a very limited set of commodities and very few of them examine whether the strength of information link might differ across markets. Within this limited amount of research, Fung, Leung, and Xu (2003) examine patterns of information flows for three commodity futures (copper, soybeans and wheat) traded in both U.S. and China markets. They find that the U.S. futures market plays a dominant role in transmitting information to the Chinese market. Further, the interaction between the two markets is strong for the commodities copper and soybeans that are subject to less government regulation and fewer import restrictions in China. For the heavily regulated and subsidized wheat commodity, the authors' empirical results indicate that the U.S.-China futures markets are highly segmented in pricing. These results imply that regulations and market distortions impact the information link of wheat futures. Lien and Yang (2006) find that the return and volatility spillovers between the two copper futures markets of London Metal Exchange (LME) and New York Mercantile Exchange (NYMEX) are bi-directional in general, but significantly stronger when the NYMEX operates at the electronic trading system. In addition, returns and volatility spillovers between LME and Shanghai Futures Exchange (SHFE) is bi-directional; however, the volatility spillover effect is uni-directional from SHFE to NYMEX.

While prior studies have analyzed the interaction between futures markets by examining the information transmission across commodity markets, reasons for variations in futures markets interactions are not clear. By examining a larger set of commodities and markets, this study hopes to provide more insight to the nature of the interaction.

More specifically, the hypothesis is that the interaction across futures commodities markets is affected by the breadth of information. The rationale is that the more diverse the information production, the stronger the interaction or information transfer among markets. Further, the direction of information transfer will tend to come from markets where most information is produced. In metal commodities, the information production is diverse and does not concentrate on one country. Thus, the futures prices of copper[5], for example, are affected by production around the world rather by a single country. In contrast, in the orange juice market, the production concentrates on one location, namely Orlando. Thus, the futures prices of orange juice should be primarily affected by the production and weather in Orlando[6]. Similarly, the supply of the Brazilian coffee[7] (the world's largest producer and exporter) should have a large impact on the futures prices in the U.S., UK and Japan coffee futures markets. Information production for copper would be much broader than those of orange juice or coffee. The information required to price the latter is more concentrated, thereby suggesting less market interaction. Stated differently, the broader the information production, the markets should be more integrated.

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[5] Brunetti and Gilbert, 1995 find that the futures prices of copper are affected by speculative pressures, and hedging activity.

[6] Roll (1984) argues that the weather in a relatively small region in Florida (Orlando) is a major determinant of supply and thus of futures prices. He examines the relation between Florida orange juice futures (FCOJ) returns and temperature surprises, and finds a statistically significant relation; however, the coefficient of determination (R^2) is between 1% and 4%. By using a nonlinear, state dependent model of the relation between FCOJ returns and temperature, Boudoukh, Richardson, Shen, and Whitelaw (2007) find that the freezing temperature around Orlando explains approximately 50% of the return variation.

[7] Coffee trees in Brazil are highly sensitive to frost and drought, leading to the spread of infectious diseases which reduces the number of trees available for production, thus driving up prices. Whereas the global consumer demand for coffee is relatively stable (see, for example, Wasserman, 2002).

To examine the importance of breadth of information and information production, I use a set of commodities and markets that are larger than the previous studies, which is one of the main contributions of this study. To measure information link, I estimate the return and volatility spillover for commodity and financial futures that are traded in multiple markets, both developed and emerging markets. Specifically, the commodities examined here include agricultural futures: coffee, corn, soybeans, and wheat, metal futures: aluminum, copper, and gold, and financial futures: India S&P CNX Nifty index futures[8] (Nifty index hereafter) and Japan Nikkei 225 index futures (Nikkei 225 hereafter). Examining these products across different markets can provide insight on whether return and volatility transmission of a commodity vary with the breadth of information required to price the commodity.

Additionally, I estimate the extent of contribution of price discovery (i.e., the extent of the feedback provided by each futures market). Harris, Mclnish, Shoesmith and Wood (1995) examine the contribution of stock price information for IBM in New York, Midwest, and Pacific Stock Exchanges. They find that IBM prices on the Midwest and Pacific Exchanges adjust to New York Stock Exchange (NYSE) prices, and vice-versa. However, NYSE contributes more to price discovery. I employ their empirical method to estimate contribution of each market. However, the methodology requires the markets to trade at the same time. Consequently, this part of research analyzes a smaller set of commodities. I investigate three sets of closely related markets that are open at the same time: wheat futures traded on Minneapolis Grain Exchange (MGE) of U.S. and Winnipeg Commodity Exchange (WCE) of Canada; aluminum futures traded on Tokyo Commodity Exchange (TCE) of Japan and SHFE of China; and the Nifty index traded on National Stock Exchange of India (NSI) and Singapore Exchange Limited (SGX).

[8] S&P CNX Nifty Index include 50 of the 1,300 companies (as of Dec 31, 2007) listed on the National Stock Exchange of India and capture almost 60% of its stock market capitalization. Nifty index traded since 1996.

In summary, I use a comprehensive set of commodities and markets, allowing a richer set of testing market interactions. The results generally support my hypothesis that the breadth of information plays a role in the intensity of market interaction. For example, I compare the persistence of interaction including and excluding the most important market, I find that when the most important market is excluded, the persistence of interaction drops substantially. This indirectly supports information breadth being a relevant factor in the strength of information link. While this conclusion might seem obvious, no study to my knowledge quantifies this. As another example, I find the degree of interaction between markets is generally lower for agricultural futures than for metals futures. This makes sense because the world supply of agricultural products such as corn tends to be more concentrated in few markets (particularly the U.S.), and therefore less markets interaction is expected.

The next section reviews the related literature, followed by section three which states the data and methodology. Section four discusses the empirical results. Section five concludes the analysis.

2. Literature Review:

Understanding information flow between markets is important for asset valuation, risk sharing, and economic policy. Previous journal articles have examined information flow across equity markets, commodity futures, and financial futures. The bulk of research focuses on studying the direction of information flow to identify which markets influence the other. The following review highlights the studies that examine the information flow across commodity futures, financial futures, and stock markets.

Several papers explore price linkages across markets with similar contracts. Booth and Ciner (1997) find a price and volatility relationship between corn futures traded at CBOT and Tokyo Grain Exchange (TGE) for the 1993–1995. They find that intraday returns on CBOT corn futures significantly affects overnight returns of the TGE corn futures. TGE is dependent on the CBOT for information generation and is expressed in opening price of TGE, which is an indication that the CBOT is the dominant market in the information transmission mechanism.

Booth, Brockman, and Tse (1998) investigate the wheat futures traded on the CBOT and the WCE of Canada and analyze the degree of information spillover between the futures exchanges of the two countries. The results show that both the U.S. and Canadian wheat futures prices are related in the long run (co-integration relationship) despite the fact that Canadian wheat is used for animal consumption only and U.S. wheat is primarily for human consumption. However, the results indicate that the WCE of Canada is dependent on CBOT, while the CBOT is not dependent on WCE. Extending the analysis of Booth et al. (1998), Yang, Zhang, and Leatham (2003) study the price and volatility transmission of wheat futures for three international wheat markets: the U.S., Canada, and the European Union (EU) for the 1996-2002 period. They find CBOT and WCE wheat futures markets influence each other. However, the influence of CBOT on WCE is greater than that of WCE on CBOT, indicating that the U.S. is a price leader in the wheat market. The London International Financial Futures Exchange (LIFFE) for EU is not affected by CBOT and WCE markets. However, LIFFE has limited influence on CBOT prices. They further find that volatility transmission is from LIFFE to the CBOT and WCE, but CBOT does not transmit volatility to the other two markets. Also, the volatility transmission is uni-directional from WCE to CBOT. They conclude that evidence from the price and volatility transmissions indicates no clear leadership role in international wheat markets.

Xu and Fung (2005) investigate the metal futures by looking at the gold, platinum, and silver futures contracts in the U.S. and Japanese markets to examine information flows between the futures exchanges of the two countries for 1994-2001. The pricing transmissions are strong across the two markets for these precious metals contracts, but information flows appear to lead from the U.S. market to the Japanese market in terms of returns, indicating the leadership role of the U.S. market in the precious metals trade. They further find that the volatility spillover feedback effects are strong between the markets, and their impacts are comparable and similar.

Analyzing the two copper futures markets LME and NYMEX, Lien and Yang (2006) find that the effect of NYMEX's electronic trading system causes a much stronger return and volatility spillovers, compared to NYMEX's floor trading system. When the copper futures for LME and SHFE of China are considered, significant bi-directional returns and volatility spillovers occur.

Hua and Chen (2007) use Johansen's co-integration test, error correction model, the Granger causality test, and impulse response analyses to examine the relationship between the Chinese futures prices and their world counterparts of copper, aluminum, soybeans, and wheat. They find a long run relationship between the futures prices on the SHFE and the futures prices on the LME for both copper and aluminum contracts. SHFE is dependent on LME with feedback. Long run relationship for soybeans futures prices between Dalian Commodity Exchange (DCE) of China and CBOT exists, however, the relationship for wheat futures prices on the Zhengzhou Commodity Exchange (ZCE) of China and CBOT is not existent. This finding is consistent with the protection policy of the Chinese government for wheat, and with the empirical results of Fung, Leung, and Xu (2003) who indicate that the U.S. and China markets are segmented in the wheat futures market. Hua and Chen (2007) further find that Dalian soybeans futures is dependent on CBOT with a feedback impact on CBOT futures.

In a study of a different type of market interaction, Holder, Pace, and Tomas III (2002) investigate the volume relationship between corn and soybeans futures for contracts traded at

CBOT's overnight electronic trading system (so-called Project A), and two Japanese exchanges, namely, (TGE) and the Kanmon Commodity Exchange (KCE), now called the Kansai Commodities Exchange. They find a complementary volume relationship between corn and soybeans futures contracts on the TGE and KCE. They also find limited evidence of an effect on Japanese contract volumes by the introduction and availability of trading on Project A. The introduction of trading on Project A should not be viewed as a direct competitive threat for the other exchanges in Japan.

Fung, Leung, and Xu (2003) examine the effect of government policies on information flows patterns for three commodity futures (copper, soybeans and wheat) traded in both U.S. and China futures markets by utilizing the bivariate vector autoregressive (AR)-Generalized autoregressive conditional heteroskedasticity (GARCH). They argue that the interaction between the U.S. and China markets is expected to be weaker for highly regulated commodities, whereas market forces play a more prominent role when commodities are subject to fewer government restrictions. The results indicate that the U.S. has a strong impact on the pricing of Chinese copper and soybeans futures but no pricing interaction for wheat futures. The authors provide an explanation for these results based on a government protection program[9]. The protection program is more applicable to wheat than to copper and soybeans. These policies weaken the interaction between the U.S. and China markets, and indeed the results indicate that the two markets are segmented. The less protected copper and soybeans products have more interaction between U.S. and China commodity futures markets, with the U.S. futures market playing a dominant role in transmitting information to the Chinese market.

[9] The protection policy of the Chinese government to wheat includes import restrictions (e.g. quota, tariffs and taxes), and a heavy subsidization program for Chinese farmers and producers.

Several papers examine price linkages among agricultural commodity futures prices in a country. Malliaris and Urrutia (1998) examine long run and short run relationships among six U.S. agricultural commodity futures contracts (corn, wheat, oat, soybeans, soybean meal, and soybean oil) that are traded on CBOT for 1981-1991. They find long run interdependence between the six commodity futures. Two explanations for the long run co-movements are provided, which are common economic fundamentals (i.e., the substitutability and complementarity of the agricultural commodities, global demand shocks[10], and weather factors), and the excess co-movement hypothesis (the presence of herding in the financial markets) of Pindyck and Rotembeg (1990).

Booth and Ciner (2001) examine which of these two explanations better clarifies the long run co-movements of agricultural commodity futures by testing the price linkages among four commodity futures (corn, redbean, soybeans, and sugar). These commodities are traded on TGE of Japan for the 1993-1998. They find no support for the long run interdependence between the four commodity futures. However, they find a long run relationship between corn and soybeans prices because both commodities are grown in the U.S. The result is consistent with common economic fundamentals and not herding behavior.

Dawson and White (2002) investigate the interdependencies between all major commodity futures contracts (barley, cocoa, coffee, sugar, and wheat) on LIFFE using Johansen's (1988) procedure for co-integration for 1991-2000. Although barley and wheat are expected to be related because they are substitutes in demand and supply, the authors find no long run relationships and no interdependence between the five commodity futures on the LIFFE. Dawson, Sanjuán, and White (2006) re-examine the long run relationship between

[10] As Malliaris and Urrutia (1998) noted: "……one should mention exogenous shocks such as the Soviet Union grain policy shift of the early 1970s and the European Economic Community's emphasis on self-sufficiency in the 1980s".

barley and wheat prices by using Johansen, Mosconi, and Nielsen's co-integration procedure that permits structural breaks. They find that the barley-wheat futures market is perfectly integrated and the barley price Granger-causes the wheat price. They justify the new result by the significant break in October 2000 following Common Agricultural Policy[11] price intervention.

Kim and Doucouliagos (2005) calculate the realized volatility and co-variation for the returns of grain futures markets (corn, soybeans and wheat) for the 1999- 2004. They find a positive relationship among the three grain futures returns. They further find strong dynamic interactions among the volatilities and correlations estimates that indicate rich spillover effects among the grain futures markets.

In financial futures, Fung, Leung, and Xu (2001) examine the patterns of information flows between U.S. and Asian markets for three financial futures contracts (Nikkei 225 listed in the U.S. and Japan, Eurodollar futures listed in U.S. and Singapore, and dollar-yen currency futures listed in the U.S. and Japan). They find that the U.S. market plays a leading role across futures markets in transmitting pricing information, indicating that their results do not support the home-bias hypothesis[12] that home market should be dominant in information transmission. They also find that foreign markets play a relatively more important role in volatility spillover, implying that volatility information is coming primarily from offshore markets. Put differently, their results confirm the important role the U.S. market plays in transmitting information to the other market (i.e., international financial center). However, Tse (1998) examines Tokyo Euroyen and Chicago Eurodollar futures data and finds that there is no evidence for volatility spillover between the U.S. and Japanese markets.

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[11] Common Agricultural Policy is a system of European Union agricultural subsidies.

[12] The home-bias phenomenon suggests that information flows between markets primarily go out from the home market (i.e., the home country plays a leading role in information transmission across markets). See, for example, Shyy and Lee (1995).

In the stock market, the results on volatility spillovers show that the information affecting return and trading volume flows from a more active market to a less active one. Studies on information transmission document a bi-directional transmission of returns and volatility between developed equity markets (e.g., Hamao, Masulis, and Ng, 1990; Koutmos and Booth, 1995), and uni-directional transmission from developed to emerging equity markets (e.g., Liu and Pan, 1997).

Wang and Firth (2004) test for return and volatility transmissions across four nearby emerging stock markets of Hong Kong, Taiwan, Shanghai and Shenzhen and three developed markets in New York, London, and Tokyo. Their empirical results indicate the existence of uni-directional contemporaneous returns, the dependence of emerging Chinese markets on New York, London and Tokyo stock markets, and the bi-directional volatility spillover effects between the developed and the emerging markets.

Some studies have shown no informational role between markets. Niarchos, Tse, Wu, and Young (1999) examine the international information flow between the U.S. and Greek stocks, but they find no support for spillovers between these markets for the conditional mean and variance equations. U.S. and Greek stock markets are not related to each other, either in the short-run or in the long-run.

3. Data and Methodology:

3.1. Sample Details:

The futures data used in the study consist of daily futures prices for the commodity futures and financial futures over the period from August 1998 to December 2008. These data are purchased from Commodity System Inc (CSI) (www.csidata.com). The data sets include open, high, low, and close prices, as well as volume and open interest for multiple contracts of each commodity futures. The generation of a single time series for futures contracts uses the nearby contract but switches to the second nearby contract one month prior to expiration.

To examine the interaction across futures markets, I estimate the pattern of information flows across world futures markets (U.S., UK, China, Japan, Canada and Brazil). All commodities, available from the data source, that are traded in multiple markets are examined.

Specifically, I cover different groups of commodity futures; agricultural futures commodities: coffee, corn, soybeans, and wheat, and metal futures: aluminum, copper, and gold. In addition, the study covers stock index futures, namely India Nifty index and Japan Nikkei 225.

Coffee futures are traded on NYMEX/CSCE of U.S., LIFFE[13] Connect (London), Brazilian Mercantile & Futures Exchange (BM&F), and TGE of Japan. Corn futures are traded on CBOT of U.S., LIFFE Connect, DCE of China, and KCX of Japan. Soybeans futures are listed on CBOT, TGE, DCE, and BM&F. Wheat futures are traded on MGE of U.S., WCE of Canada, LIFFE Connect, and Zhengzhou Commodity Exchange (ZCE) of China. Aluminum futures are traded on NYMEX/COMEX, TCE of Japan, and SHFE of China. Copper futures are traded on NYMEX/COMEX and SHFE. Gold futures are traded on NYMEX/COMEX, TCE, and SHFE. Nifty index is listed on NSI of India and SGX of Singapore. Japan Nikkei 225 is listed on Osaka Security Exchange (OSE), Chicago Mercantile Exchange (CME), and SGX. Appendix 1 reports the contract specifications of commodity and financial futures across world futures markets.

To make the data of futures prices series comparable across world futures markets (U.S., UK, China, Japan, Canada and Brazil), the quotation units are consolidated for the data series and the daily prices are adjusted to U.S. dollars using daily exchange rate provided by Wharton Research Data Services (WRDS). For example, the quotation unit for corn futures contracts is

[13] LIFFE is now a part of Euronext..

cents per bushel (on CBOT), Euro per metric ton (on LIFFE Connect), Japanese yen per ton (on KCX), and Chinese yuan per metric ton (on DCE). The entire quotation unit is converted into U.S. dollar per bushel for all corn futures contracts. Additionally, the stock index futures are also adjusted to exchange rate (see Appendix 2).

Table 1 presents the descriptive statistics on daily futures returns. Non-matching data caused by the holidays in the world futures markets is excluded to make the data for futures prices series more comparable. The numbers of daily observations are 2277, 971, 685, 1046, 1147, 1204, 212, 655, and 2478 for coffee, corn, soybeans, wheat, aluminum, copper, gold, Nifty index, and Nikkei 225 futures, respectively.

The distribution of the daily futures returns is non-normal according to the Jarque-Bera (J-B) test (the null hypothesis of normality is rejected by Jarque-Bera test) and characterized by a significant kurtosis and skewness for all futures series. The daily futures returns in most cases are negatively skewed. The kurtosis and skewness coefficients indicate that the non-normality is mostly due to excess kurtosis (fatter tails than the normal distribution) rather than the skewness since the skewness coefficients are close to zero compared to kurtosis coefficients that are outside the range -3 to +3 (see Table 1).

The price series is tested for stationarity using the Augmented Dickey-Fuller (ADF) unit root tests (where I include an intercept with a trend term and an intercept without a trend term). Consistent with the previous literature, the study's results suggest that the futures prices series are non-stationary (the null hypothesis of a unit root is not rejected in the logarithm of futures price series) and their first differences are stationary (see Table 2). This means that the use of a return measure for the commodities in the GARCH model is supported.

Table 1
Summary Statistics on Daily Futures Returns

This table summarizes sample statistics on daily futures returns. Daily returns of coffee, corn, soybeans, wheat, aluminum, copper, gold, S&P CNX Nifty, and Nikkei 225 futures are calculated as the difference in daily natural logarithmic of futures prices. The dataset used in this study is the daily closing futures price. The Jarque-Bera statistic is distributed as χ^2 and tests for normality; the null hypothesis is that the data set is similar to the normal distribution. a, b, and c refer to significance at 1,5,10% levels, respectively.

	Obs.	Mean	Variance	Min	Max	skewness	kurtosis	Jarque-Bera
Agricultural Futures: Coffee Contracts								
U.S.	2277	3.00E-05	5.80E-04	-0.135	0.322	1.155[a]	18.169[a]	31828.03[a]
UK	2277	6.00E-05	3.80E-04	-0.130	0.122	-0.064	4.619[a]	2026.00[a]
Brazil	2277	7.00E-05	5.10E-04	-0.137	0.343	1.554[a]	28.277[a]	76775.80[a]
Japan	2277	-3.00E-05	7.10E-04	-0.124	0.186	0.289[a]	2.557[a]	652.15[a]
Agricultural Futures: Corn Contracts								
U.S.	971	6.40E-04	4.60E-04	-0.237	0.089	-1.467[a]	16.430[a]	11269.73[a]
UK	971	2.80E-04	2.60E-04	-0.199	0.080	-1.889[a]	27.820[a]	31890.94[a]
China	971	4.70E-04	8.00E-05	-0.051	0.052	0.8478[a]	7.077[a]	2142.53[a]
Japan	971	2.70E-04	2.80E-04	-0.154	0.186	1.350[a]	27.016[a]	29823.85[a]
Agricultural Futures: Soybeans Contracts								
U.S.	685	7.67E-04	4.27E-04	-0.229	0.071	-2.276[a]	23.613[a]	16482.43[a]
China	685	4.62E-04	9.04E-04	-0.201	0.127	-0.612[a]	9.525[a]	2628.64[a]
Japan	685	4.62E-04	5.59E-04	-0.201	0.127	-0.612[a]	9.525[a]	2628.64[a]
Brazil	685	6.78E-04	2.70E-04	-0.202	0.067	-2.766[a]	33.221[a]	32327.19[a]
Agricultural Futures: Wheat Contracts								
U.S.	1046	8.65E-04	3.43E-04	-0.163	0.093	-0.550 [a]	8.574[a]	3254.25[a]
Canada	1046	9.28E-04	2.26E-04	-0.062	0.088	0.449[a]	3.166[a]	471.76[a]
UK	1046	3.91E-04	2.77E-04	-0.253	0.060	-4.79[a]	66.551[a]	196857.80[a]
China	1046	2.63E-04	8.00E-05	-0.042	0.112	2.749[a]	30.436[a]	41651.70[a]
Metal Futures: Aluminum Contracts								
U.S.	1147	-1.00E-05	2.90E-04	-0.107	0.055	-0.702[a]	3.763[a]	771.00[a]
China	1147	-1.10E-04	1.40E-04	-0.059	0.073	-0.416[a]	3.898[a]	759.03[a]
Japan	1147	-3.00E-05	2.80E-04	-0.188	0.056	-2.597[a]	25.175[a]	31578.90[a]
Metal Futures: Copper Contracts								
U.S.	1204	2.50E-04	5.40E-04	-0.209	0.116	-0.778[a]	8.263[a]	3556.07[a]
China	1204	2.20E-04	3.30E-04	-0.077	0.074	-0.322[a]	1.005[a]	71.91[a]
Metal Futures: Gold Contracts								
U.S.	212	-9.00E-05	4.20E-04	-0.060	0.086	0.339[b]	1.565[a]	25.68[a]
China	212	-2.10E-04	3.90E-04	-0.077	0.070	-0.614[a]	2.281[a]	59.28[a]
Japan	212	2.00E-05	5.60E-04	-0.080	0.062	-0.405[b]	1.384[a]	22.69[a]
Financial Futures: S&P CNX Nifty(India) Index Contracts								
SGP	655	1.77E-03	9.70E-04	-0.367	0.194	-2.607[a]	40.031[a]	44409.70[a]
India	655	1.73E-03	1.39E-03	-0.445	0.201	-2.914[a]	40.951[a]	46473.48[a]
Financial Futures: Nikkei 225 Contracts								
U.S.	2478	-2.34E-04	3.05E-04	-0.108	0.164	0.080[c]	8.067[a]	6716.85[a]
SGP	2478	-7.70E-05	2.92E-04	-0.111	0.124	-0.018	4.461[a]	2053.08[a]
Japan	2478	-7.40E-04	3.14E-04	-0.132	0.166	-0.017	7.955[a]	6526.29[a]

Table 2
Augmented Dickey-Fuller Test for Unit Root

The table presents the results of the Augmented Dickey Fuller (ADF) test. The ADF includes intercept without trend term and both intercept and trend term. a, b, and c refer to significance at 1,5,10% levels, respectively.

Market	**Price Series**		**Return Series**	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
Agricultural Futures: Coffee Contracts				
U.S.	-2.002	-2.590	-49.847[a]	-49.848[a]
UK	-0.911	-1.857	-35.016[a]	-35.091[a]
Brazil	-1.539	-2.130	-48.661[a]	-48.662[a]
Japan	-1.960	-2.386	-46.140[a]	-46.145[a]
Agricultural Futures: Corn Contracts				
U.S.	-1.203	-1.551	-30.325[a]	-30.317[a]
UK	-1.155	0.026	-29.384[a]	-29.462[a]
China	-1.028	-1.758	-30.970[a]	-30.966[a]
Japan	-1.093	-0.751	-18.385[a]	-18.395[a]
Agricultural Futures: Soybeans Contracts				
U.S.	-1.156	-0.803	-27.935[a]	-27.945[a]
China	-1.148	-0.206	-24.970[a]	-25.006[a]
Japan	-1.265	-0.961	-26.488[a]	-26.502[a]
Brazil	-1.244	-0.402	-24.513[a]	-24.548[a]
Agricultural Futures: Wheat Contracts				
U.S.	0.081	-1.763	-31.349[a]	-31.382[a]
Canada	1.181	-1.468	-31.389[a]	-31.568[a]
UK	-0.077	-2.521	-29.659[a]	-2975330[a]
China	-0.172	-1.113	-33.751[a]	-33.823[a]
Metal Futures: Aluminum Contracts				
U.S.	-1.395	0.115	-37.785[a]	-37.952[a]
China	-1.270	-0.059	-30.623[a]	-30.744[a]
Japan	-1.221	0.759	-37.925[a]	-38.112[a]
Metal Futures: Copper Contracts				
U.S.	-1.262	0.809	-38.719[a]	-38.979[a]
China	-1.386	0.814	-31.130[a]	-31.424[a]
Metal Futures: Gold Contracts				
U.S.	-1.734	-2.582	-13.172[a]	-13.141[a]
China	-1.713	-2.362	-13.117[a]	-13.090[a]
Japan	-1.093	-2.920	-15.885[a]	-15.848[a]
Financial Futures: S&P CNX Nifty(India) Index Contracts				
Singapore	-2.425	-1.339	-25.107[a]	-25.252[a]
India	-2.299	-1.190	-25.615[a]	-25.754[a]
Financial Futures: Nikkei 225 Contracts				
U.S.	-1.415	-1.451	-54.573[a]	-54.565[a]
Singapore	-1.501	-1.496	-53.550[a]	-53.542[a]
Japan	-1.533	-1.528	-54.805[a]	-54.795[a]

3.2. Dynamic Conditional Correlation Model:

The study uses the Dynamic Conditional Correlation (DCC) framework developed by Engle (2002). The model allows for a time-varying correlation rather than the Bollerslev (1990) constant conditional correlation (CCC) estimator. The extracted dynamic conditional correlations can be used to identify the interdependence and volatility transmission across futures that are listed in different futures markets since the dynamics correlation are modeled in conjunction with those of the volatility of the series. This model is suitable because it directly infers the cross-market dynamic correlations (international correlations), which are not constant over time (Berben and Jansen, 2005). The DCC is a two step model. In the first step, the conditional volatilities from a univariate GARCH model for each individual futures price series are estimated. In the second step (dynamic correlation part), the standardized version of the residuals estimated from the first step is used to estimate the parameters of the conditional correlation.

To model the dynamic relationships across futures markets, the Vector Autoregressive VAR(p)-DCC model is used, which can be presented as follows:

$$\begin{bmatrix} r_{1,t} \\ \vdots \\ r_{N,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ \vdots \\ c_N \end{bmatrix} + \begin{bmatrix} \phi_{11,1} & \cdots & \phi_{1N,1} \\ \vdots & \ddots & \vdots \\ \phi_{N1,1} & \cdots & \phi_{NN,1} \end{bmatrix} \begin{bmatrix} r_{1,t-1} \\ \vdots \\ r_{N,t-1} \end{bmatrix} + \cdots + \begin{bmatrix} \phi_{11,p} & \cdots & \phi_{1N,p} \\ \vdots & \ddots & \vdots \\ \phi_{N1,p} & \cdots & \phi_{NN,p} \end{bmatrix} \begin{bmatrix} r_{1,t-p} \\ \vdots \\ r_{N,t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{N,t} \end{bmatrix}$$

$where \quad \varepsilon_t \mid I_{t-1} \sim N(0, H_t)$

$H_t = D_t R_t D_t,\ where\ H_t$ is the conditional covariance matrix (1)

In the mean return equation of this model, $r_{i,t}$ is a $(N \times 1)$ vector of the log difference of futures prices for each series; p is lag order of VAR model, C is the $(N \times 1)$ vector whose elements are constants; ϕ is a $(N \times N)$ matrix of the coefficients on the past returns; and I_{t-1} is the past information until time $t-1$. Whereas, in the variance covariance structure of this model R_t

is a $(N \times N)$ time varying correlation matrix, and D_t is a $(N \times N)$ diagonal matrix of time varying standard deviations obtainable from univariate GARCH processes given as follows:

$$D_t = \begin{bmatrix} \sqrt{h_{1,t}} & 0 & \cdots & 0 \\ 0 & \sqrt{h_{2,t}} & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & \sqrt{h_{N,t}} \end{bmatrix} \quad (2)$$

The elements on its main diagonal of D_t are the conditional standard deviations of the returns on each futures series ($\sqrt{h_{N,t}}$) and can be written as (i.e., GARCH(1,1) process):

$$h_{i,t} = \omega_i + \theta_i h_{i,t-1} + \gamma_i \varepsilon_{i,t-1}^2 \text{, where } i = 1,\ldots,N \quad (3)$$

where $h_{i,t}$ is the conditional volatility, $\varepsilon_{i,t-1}^2$ are the past squared errors, and $\omega_i, \theta_i, \gamma_i$ are coefficients.

Volatility spillover and co-movement, as in (Fratzscher, 2001; and Balasubramanyan, 2004), is incorporated into the conditional variance model ($h_{i,t}$) to capture the volatility linkage effects across the futures price series. The study defines cross market lagged squared error as spillover and contemporaneous cross market squared error as co-movement. The distinction between spillover and co-movement is via the order of exchange market closing times. For example, if the influence of Japanese market on U.S. traded futures is studied, $\varepsilon_{JPN,t}^2$ is considered as "co-movement" because the Japan market affects the U.S. market on the same day, and the U.S market affects the Japanese market on the following calendar day (i.e., Japanese market on day t closes before the U.S. market opens on day t). Appendix 3 gives an overview of the trading hours in Greenwich Mean Time for futures markets. With the spillover and co-movement effect, the conditional variance equations ($h_{i,t}$) can be rewritten as:

$$h_{i,t} = \omega_i + \theta_i h_{i,t-1} + \gamma_i \varepsilon_{i,t-1}^2 + \underbrace{\sum_j \lambda_{ij} \varepsilon_{j,t-1}^2}_{spillover} + \underbrace{\sum_k \lambda_{ik} \varepsilon_{k,t}^2}_{comovment} \text{, } i:1,\ldots,N \quad (4)$$

where j refers to countries that have no overlapping trading hours with market i, while k refers to countries that have longer overlapping trading hours with market i.

Engle's (2002) DCC structure can be presented as:

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{5}$$

$$Q_t = (1 - \sum_{m=1}^{M} a_m - \sum_{n=1}^{N} b_n)\overline{Q} + \sum_{m=1}^{M} a_m (u_{t-m} u_{t-m}^{'}) + \sum_{n=1}^{N} b_n Q_{t-n}$$

When $m = n = 1$, then

$$Q_t = (1 - \alpha - \beta)\overline{Q} + \alpha u_{t-1} u_{t-1}^{'} + \beta Q_{t-1} \tag{6}$$

where $\overline{Q}$ is the unconditional correlation matrix of $u's$; $u_{i,t} = \varepsilon_{i,t} / \sqrt{h_{i,t}}$ (standardized error from GARCH), α and β scalars representing the recent co-movements and the persistency of the correlation between two futures series, respectively. α and β are nonnegative scalar parameters satisfying $\alpha + \beta < 1$ to insure that H_t is positive definite (mean reverting DCC). If α and β are zero, one obtains the CCC model (Bollerslev, 1990) and Q_t is simply $\overline{Q}$. Moreover, α and β are the only two parameters that drive the dynamics of all the correlations (Jondeau, Poon, Rockinger, 2007).

As for R_t, it can be written as:

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1}$$

$$= \begin{bmatrix} 1/\sqrt{q_{11,t}} & 0 & \cdots & 0 \\ 0 & 1/\sqrt{q_{22,t}} & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & 1/\sqrt{q_{NN,t}} \end{bmatrix} \begin{bmatrix} q_{11,t} & q_{12,t} & \cdots & q_{1N,t} \\ q_{21,t} & q_{22,t} & & \\ \vdots & & \ddots & \vdots \\ q_{N1,t} & & \cdots & q_{NN,t} \end{bmatrix} \begin{bmatrix} 1/\sqrt{q_{11,t}} & 0 & \cdots & 0 \\ 0 & 1/\sqrt{q_{22,t}} & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & 1/\sqrt{q_{NN,t}} \end{bmatrix}$$

$$= \begin{bmatrix} 1 & q_{12,t}/\sqrt{q_{11,t} q_{22,t}} & \cdots & q_{1N,t}/\sqrt{q_{11,t} q_{NN,t}} \\ q_{21,t}/\sqrt{q_{11,t} q_{22,t}} & 1 & & \\ \vdots & & \ddots & \vdots \\ q_{N1,t}/\sqrt{q_{11,t} q_{NN,t}} & & \cdots & 1 \end{bmatrix}$$

$$
= \begin{bmatrix} 1 & \rho_{12,t} & & \rho_{1N,t} \\ \rho_{21,t} & 1 & & \\ \vdots & & \ddots & \vdots \\ \rho_{N1,t} & & \cdots & 1 \end{bmatrix} \tag{7}
$$

where ρ_{ij} is the conditional correlation. ρ_{ij} ($\rho_{ij} = q_{ij,t} \big/ \sqrt{q_{ii,t} q_{jj,t}}$) indicates the extent to which covariance between two futures series is related to the market's individual variance.

To estimate conditional covariance matrix (H_t) parameters:

$$
H_t = D_t R_t D_t = \begin{bmatrix} h_{11,t} & & & \\ \rho_{21,t}\sqrt{h_{11,t}h_{22,t}} & h_{22,t} & & \\ \vdots & & \ddots & \\ \rho_{N1,t}\sqrt{h_{NN,t}h_{11,t}} & \rho_{N2,t}\sqrt{h_{NN,t}h_{22,t}} & \cdots & h_{NN,t} \end{bmatrix} \tag{8}
$$

I use a Quasi-Maximum Likelihood (QML) estimator over the parameters of the model (Engle, 2002):

$$
\begin{aligned}
L(\Psi) &= -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi) + \log\left|H_t\right| + r_t' H_t^{-1} r_t) \\
&= -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi) + \log\left|D_t R_t D_t\right| + r_t' D_t^{-1} R_t^{-1} r_t) \\
&= -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi) + 2\log|D_t| + \log|R_t| + \varepsilon_t' R_t^{-1}\varepsilon_t)
\end{aligned} \tag{9}
$$

where $\Psi = (\varphi, \kappa)$; $\varphi = (c_1, \phi_1, \omega_1, \theta_1, \gamma_1, \lambda_1, \cdots c_N, \phi_{NN}, \omega_N, \theta_N, \gamma_N, \lambda_{NN})$; $\kappa = (\alpha, \beta)$

Estimation of the model occurs in two steps since the log-likelihood function above has two parts namely, the volatility part in (D_t) and the correlation part in (R_t). In the first stage, the log-likelihood function is maximized only over the parameters in volatility component, while in the second stage, the correlation component of the likelihood function is maximized given the estimates of the (D_t) that results from the first stage. All computations are carried out using WinRats software.

I estimate a number of futures series together with the same underlying commodities using VAR-DCC(1,1) model. For example, in the case of trivariate VAR-DCC $(N = 3)$, the mean conditional equations can be written:

$$
\begin{aligned}
r_{1.t} &= c_1 + \phi_{11} r_{1,t-1} + \phi_{12} r_{2,t-1} + \phi_{13} r_{3,t-1} + \varepsilon_{1,t} \\
r_{2.t} &= c_2 + \phi_{21} r_{1,t-1} + \phi_{22} r_{2,t-1} + \phi_{23} r_{3,t-1} + \varepsilon_{2,t} \\
r_{3.t} &= c_3 + \phi_{31} r_{1,t-1} + \phi_{32} r_{2,t-1} + \phi_{33} r_{3,t-1} + \varepsilon_{3,t}
\end{aligned} \tag{10}
$$

The variance conditional equations with volatility spillover are presented as follows:

$$
\begin{aligned}
h_{11,t} &= \omega_1 + \theta_{11} h_{11,t-1} + \gamma_{11} \varepsilon_{1,t-1}^2 + \lambda_{1,2} \varepsilon_{2,t-1}^2 + \lambda_{1,3} \varepsilon_{3,t-1}^2 \\
h_{22,t} &= \omega_2 + \theta_{22} h_{22,t-1} + \gamma_{22} \varepsilon_{2,t-1}^2 + \lambda_{2,1} \varepsilon_{1,t-1}^2 + \lambda_{2,3} \varepsilon_{3,t-1}^2 \\
h_{33,t} &= \omega_3 + \theta_{33} h_{33,t-1} + \gamma_{33} \varepsilon_{3,t-1}^2 + \lambda_{3,1} \varepsilon_{1,t-1}^2 + \lambda_{3,2} \varepsilon_{2,t-1}^2
\end{aligned} \tag{11}
$$

The DCC parameter vector for this case (N=3) is 29x1 while it is 46x1 parameter vector for the case of four markets $(N = 4)$.

3.3. Price Discovery in Futures Markets:

The study examines the contribution of one market to the price discovery of other markets (i.e., the contribution of each market to price discovery process). A market contributes to price discovery process if the feedback provided by that market drives prices in the other market. For example, if the prices on WCE of Canada adjust to CBOT prices, then U.S. is contributing to the price discovery. Two common approaches have been used to estimate price discovery, the common factor components of Gonzalo and Granger (1995) and Harris et al. (1995, 2002), and the information share of Hasbrouck[14] (1995). Both approaches provide measures for price discovery based on the vector error correction model (VECM). Prior studies estimate the price discovery for equity markets. This study examines the relative contribution of one market to price discovery of other market for commodity futures, which represents another contribution of the study.

The methodology can be applied only to markets that are open at the same time. Therefore, the sets of markets examined here are smaller. Specifically, the study examines the price discovery of wheat futures traded on MGE of U.S. and WCE of Canada; aluminum futures

[14]Hasbrouck (1995) termed the market's contribution to price discovery as the market's information share (i.e., a market's relative proportion to the innovation variance of the efficient price).

traded on TCE of Japan and SHFE of China; and Nifty index traded on NSI of India and SGX of Singapore. These markets have overlapping trading hours (informational-linked markets) and their futures prices are co-integrated of order 1. The series that are integrated of order zero are excluded (e.g. corn, soybeans, and gold futures that are traded in China and Japan).

To assess this contribution, the error correction approach used by Harris et al. (1995) is employed. First, unit root tests are performed for prices of each commodity futures to see whether price series are integrated of order 1. Then, the Johansen (1988) method is used to confirm the co-integration of prices for each commodity futures, and to find the number of co-integrating vectors. For example, P_t^m and P_t^n are the futures prices for market m and n, respectively for a specific commodity futures. To be able to estimate the error correction model, the P_t^m and P_t^n series should be non stationary and integrated of order 1, denoted as $I(1)$. Moreover, P_t^m and P_t^n are co-integrated if there is a linear combination between the two price series $\gamma^m P_t^m + \gamma^n P_t^n$ that is stationary.

The error correction model (ECM) shown below is performed for each commodity futures:

$$\Delta P_t^m = c_o^m + \tau^m (P_{t-1}^m + \upsilon^n P_{t-1}^n) + \sum_{q=1}^{Q} \delta_q \Delta P_{t-q}^m + \sum_{q=1}^{Q} \eta_q \Delta P_{t-q}^n + \varepsilon_t^m \quad (12)$$

$$\Delta P_t^n = c_o^n + \tau^n (P_{t-1}^m + \upsilon^n P_{t-1}^n) + \sum_{q=1}^{Q} \delta_q \Delta P_{t-q}^m + \sum_{q=1}^{Q} \eta_q \Delta P_{t-q}^n + \varepsilon_t^n \quad (13)$$

Where ΔP_t^m and ΔP_t^n are the first log difference of the futures prices for market m and n, respectively. υ^n is the co-integrated vector coefficient between the two markets such that $\upsilon^m P_{t-1}^m + \upsilon^n P_{t-1}^n$ is co-integrated of order 1, denoted by $I(1)$. Q is the number of the lags in the model based on multivariate Schwarz Bayesian criterion. The coefficient of the error correction term τ^m and τ^n (adjustment coefficients) indicate the responsiveness of the price series to any deviation from the equilibrium relationship (i.e., the deviation of price difference between the market m and n from zero).

By estimating the magnitudes of the response of the market m (τ^n) and market n (τ^m), the relative contribution of one market to the price discovery process (i.e., share in price discovery) by following Schwarz and Szakmary (1994) can be calculated:

$$m \text{ market share in price discovery} = \Theta = \frac{\left|\tau^{n}\right|}{\left|\tau^{n}\right| + \tau^{m}} \tag{14}$$

Where $\left|\tau^{n}\right| + \tau^{m}$ represents the total adjustment to restore the equilibrium relation of prices. A higher value of Θ reflects a larger contribution from the market *m*. Similarly, the higher the value of $1-\Theta$, the larger the contribution of market *n*.

4. Empirical Results:

4.1. Summary of the Markets

Markets vary substantially in terms of size and liquidity. Table 3 summarizes the means of the Amihud daily illiquidity measure and the modified measure version of Amihud (Hasbrouck, 2005) for financial and commodity futures. Amihud daily illiquidity measure is calculated as: $\frac{\left|R_{id}\right|}{DVOL_{id}} \times 10^{6}$ (i.e., the absolute percentage price change, R_{id} per million dollars of trading value, $DVOL_{id}$), whereas, the modified measure version of Amihud can be calculated as:

$$\sqrt{Amihud} = \sqrt{\frac{\left|R_{id}\right|}{DVOL_{id}} \times 10^{6}}.$$

Both measures give similar results for the level of market liquidity. The U.S. is ranked on top in all commodity futures except aluminum and copper; whereas, China ranked first in the two aforementioned commodities. India and Japan are ranked first, based on liquidity, in Nifty index and Nikkei 225 index, respectively.

Table 3 also summarizes the daily trading value in million dollars for commodity and financial futures (as a proxy measure of market size) and reports the mean of daily growth rate of trading volume during the study period. Table 3 reveals that the following markets experience the highest growth rate in dollar trading volume (of roughly 4% a year): Aluminum and Nikkei 225 in U.S., Wheat traded in Canada, and Copper in China. Other markets' growth rate is often less than 1%. The fast growth in some futures traded in the U.S. is somewhat surprising in spite of its relatively mature market; it suggests that liquidity begets additional liquidity.

Table 3
Market Liquidity and Market Size

This table summarizes the means of the Amihud daily illiquidity measure and the modified measure version of Amihud (Hasbrouck, 2005) for commodity and financial futures. Countries ranked based on liquidity; "1" being the most liquid market and "3" being the least liquid market. The table also lists the daily trading value in million dollars for commodity and financial futures and reports the mean of daily growth rate of trading volume (%).

Market	Amihud Ratio		Modified Amihud		Trading Volume		
	Mean Illiquidity	**Rank Liquidity**	**Mean Illiquidity**	**Rank Liquidity**	**Mean (US Millions)**	**Rank Liquidity**	**Growth Rate (%)**
Agricultural Futures: Coffee Contracts							
U.S.	4.94E-11	1	6.16E-06	1	467	1	0.15
UK	3.87E-10	2	1.68E-05	2	67	3	0.16
Brazil	2.90E-09	4	2.97E-05	4	24	4	0.26
Japan	4.31E-10	3	1.74E-05	3	85	2	0.12
Agricultural Futures: Corn Contracts							
U.S.	1.54E-11	2	3.35E-06	2	1,320	1	0.07
UK	9.38E-09	4	6.50E-05	4	4	4	1.89
China	1.02E-11	1	2.68E-06	1	823	2	0.08
Japan	3.36E-09	3	4.28E-05	3	13	3	0.21
Agricultural Futures: Soybeans Contracts							
U.S.	9.76E-12	1	2.65E-06	1	1,850	2	0.05
China	2.18E-11	2	3.28E-06	2	2,630	1	0.31
Japan	2.66E-10	3	1.35E-05	3	92	3	0.15
Brazil	4.29E-09	4	5.04E-05	4	6	4	0.53
Agricultural Futures: Wheat Contracts							
U.S.	9.61E-11	1	8.82E-06	1	168	1	0.09
Canada	8.39E-08	3	1.92E-04	3	1	4	3.28
UK	2.98E-09	2	4.41E-05	2	7	3	0.59
China	1.51E-08	4	7.85E+02	4	45	2	1.11
Metal Futures: Aluminum Contracts							
U.S.	4.00E-02	3	1.33E-01	3	4	3	4.85
China	2.24E-05	1	3.94E-03	1	810	1	0.87
Japan	3.13E-03	2	2.49E-02	2	14	2	0.30
Metal Futures: Copper Contracts							
U.S.	2.20E-07	1	4.14E-04	2	93,800	2	0.08
China	4.08E-07	2	2.65E-04	1	355,000	1	3.16
Metal Futures: Gold Contracts							
U.S.	1.25E-06	1	1.01E-03	1	13,500	1	0.05
China	2.97E-05	3	4.29E-03	3	786	3	0.32
Japan	1.37E-05	2	3.07E-03	2	1,720	2	0.12
Financial Futures: S&P CNX Nifty(India) Index Contracts							
Singapore	4.79E-02	2	8.78E-02	2	53	2	0.94
India	7.40E-06	1	2.33E-03	1	1,800	1	0.15
Financial Futures: Nikkei 225 Contracts							
U.S.	7.21E-03	3	3.14E-02	3	112	3	3.66
Singapore	8.81E-06	2	2.49E-03	2	2,280	2	0.08
Japan	2.34E-06	1	1.30E-03	1	7,050	1	0.05

4.2. DCC Model Results:

The model is estimated by maximizing the quasi-maximum likelihood estimator over the parameters of the model (Engle, 2002), following the algorithms of Broyden-Fletcher-Goldfarb-Shanno (BFGS). In the following subsections, the overall results of VAR-DCC model are reported for the agricultural, metal futures, and stock indices[15], and are discussed further.

4.2.1. Agricultural Futures:

The estimated results from the DCC model for the same underlying commodity traded in multiple markets show the price impact from one market to another, the information flow across futures markets, and the dynamic conditional correlation over the markets.

First look at coffee futures traded in the U.S., UK, Brazil, and Japan. Table 4 shows that the price impact from Brazil to U.S. and UK is significant and stronger than that from U.S. and UK. This result can be explained by the fact that Brazil accounts for 28.9% of world's coffee exports and is the world's largest producer: see Table 5. In terms of the cross-market information flow, the results indicate that the co-movement effect tends to be bi-directional from one market to another.

The persistence of dynamic conditional correlation process (i.e., DCC-β) for the full model (i.e., all coffee futures markets are included) is moderate with a value of 0.635. This implies that the current co-movement of returns is not strongly influenced by the previous dynamic correlations as described in equation 6. Further, the DCC-β estimate for coffee futures declines from 0.635 to 0.583 when I exclude the Brazilian market, where information is likely to be concentrated.

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[15] Figures 1 through 9 plot the estimated conditional correlations between markets for the sample period. Generally, the figures indicate that the behavior of these correlations is not constant over time, which justifies the use of the DCC modeling structure (see Appendix 4).

Table 4
VAR-DCC Model Estimation Results for Coffee Futures Traded in United States, United Kingdom, Brazil, and Japan

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S., UK, Brazil, and Japan futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for coffee futures includes U.S., UK, and Japan futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	**United Kingdom**	**Brazil**	**Japan**
Panel A: Mean return equation for the full model				
Constant term	2.63e-06	1.59e-04	6.19e-06	3.49e-04
U.S. market return lag 1	-0.1235[a]	0.0434[a]	-2.47e-03	0.6404[a]
UK market return lag 1	-0.0312[b]	-0.0174[a]	-0.0371[a]	0.0506[a]
BRA market return lag 1	0.1629[a]	0.0665[a]	0.0315[a]	-0.0266
JPN market return lag 1	-0.0401[a]	-0.0329[a]	-0.0268[a]	-0.0650[a]
Panel B: Variance equation for the full model				
Constant term	1.06e-04[a]	7.60e-05[a]	8.23e-05[a]	2.23e-04[a]
GARCH coefficient	0.4190[a]	0.4898[a]	0.4369[a]	0.3219[a]
ARCH coefficient	0.1820[a]	0.1998[a]	0.1524[a]	0.1893[a]
U.S. market volatility	--	-0.0267[a]	0.0212[a]	0.0414[a]
UK market volatility	0.1258[a]	--	0.1366[a]	0.0534[a]
BRA market volatility	0.0164[a]	0.0896[a]	--	0.0198
JPN market volatility	0.1042[a]	0.0378[a]	0.1019[a]	--
Panel C: DCC parameters and model characteristics for the full model and reduced model(s)				
Countries	α	β	Log-Likelihood:	Sample Size
U.S., UK, Brazil, and Japan	0.0631[a]	0.6352[a]	25261.10	2277
U.S., UK, and Japan	0.0568[a]	0.5828[a]	17441.60	2277

Table 5
World Market of Coffee

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	0.14%	17%	0.00	0.00	23.7%
UK	0.00	2.2%	0.00	0.00	4.3%
Brazil	33.6%	13.3%	63.8%	28.9%	0.00
Japan	00.0	5.9%	0.00	0.00	7.8%

Source: International Coffee Organization. http://www.ico.org/

Corn futures are traded in the U.S., UK, China, and Japan. Table 6 shows that the U.S. has the strongest price impact on the Chinese, UK, and Japanese markets with a value of 0.096, 0.048, and 0.190, respectively. One possible explanation is that the U.S. markets tend to have more trading, and control 66.5% of world corn trade (i.e., has a high comparative advantage index, calculated by dividing country export by world exports), and that makes it more informative. This is shown in Table 7. The results also suggest a stronger volatility spillover from U.S. to the Chinese, UK, and Japanese corn markets and from China to that of Japan. This result is consistent with the greater liquidity level in the U.S. and China.

The DCC-β across corn futures in the U.S., UK, China, and Japan is moderate with a value of 0.678. A re-estimated DCC-β value excluding the U.S. is lower at 0.353. This is consistent with the U.S. being the most important market, the most liquid one in term of daily trading value, and has the strongest price impact on China, Japan, and UK futures markets. Therefore, the information production might be a relevant factor in the dynamic correlation across futures markets.

Table 6
VAR-DCC Model Estimation Results for Corn Futures Traded in United States, United Kingdom, China, and Japan

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S., UK, China, and Japan futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for corn futures includes UK, China, and Japan futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United State	**United Kingdom**	**China**	**Japan**
Panel A: Mean return equation for the full model				
Constant term	5.24e-04	5.57e-04[c]	4.90e-04[b]	7.81e-04[a]
U.S. market return lag 1	-0.087[a]	0.048[b]	0.096[a]	0.1908[a]
UK market return lag 1	-0.09[a]	0.055[a]	-0.013	0.0370
CHN market return lag 1	0.110[a]	-0.025	8.18e-03[a]	-0.0661
JPN market return lag 1	0.0844[a]	-0.047[c]	-3.37e-03	0.0985[a]
Panel B: Variance equation for the full model				
Constant term	7.11e-05[a]	6.46e-06[a]	2.93e-05[a]	4.62e-05[a]
GARCH coefficient	0.609[a]	0.671[a]	0.033[c]	0.0557[a]
ARCH coefficient	0.171[a]	0.194[a]	0.195[a]	0.5494[a]
U.S. market volatility	--	0.033[a]	0.066[a]	0.2085[a]
UK market volatility	0.096[a]	--	6.21e-03	-2.75e-03
CHN market volatility	-7.56e-03	-4.02e-03	--	0.4524[a]
JPN market volatility	0.050[c]	0.073[a]	0.028[a]	--
Panel C: DCC parameters and model characteristics for the full model and reduced model(s)				
Countries	α	β	Log-Likelihood	Sample Size
U.S., UK, China, and Japan	0.0447[a]	0.6779[a]	11584.91	971
UK, China, and Japan	0.0822[a]	0.3525[b]	8942.498	973

Table 7
World Market of Corn

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	40%	31.6%	19.1%	66.5%	0.47%
UK	0.00	0.00	0.00	0.00	NA
China	21%	20%	0.30%	0.50%	0.12%
Japan	0.00	2.3%	0.00	0.00	20.2%

Source: Untied States Department of Agriculture (http://www.usda.gov).
N/A: Not Available.

The market power story also is applicable to soybeans futures traded in the U.S., Brazil, China, and Japan. The soybeans market is dominated by U.S. and Brazil who account for 37% and 39% of world soybeans trade, respectively. Overall, Table 8 indicates that the U.S. has an important role in return spillover on the Chinese, Brazilian, and Japanese soybeans markets with a value of 0.355, 0.203, and 0.437, respectively. However, Brazil does not exert a significant return spillover to the other markets even though it is a slightly bigger exporter than the U.S., possibly explained by its relatively illiquid market. Table 8 also reveals that the volatility co-movement from Brazil to China is bi-directional, and it is stronger from Brazil to China. This finding might be explained by the fact that China is a major importer of Brazilian soybeans. Additionally, the spillover from U.S. into China and Japan is bi-directional and significant.

The DCC-β across soybeans futures traded in U.S., China, Japan, and Brazil is moderate with a value of 0.704. Excluding the most informative markets (U.S. and Brazil), the DCC-β declines to 0.563. Further, the DCC-β estimate is also lower after excluding either U.S. or Brazil markets where most information is produced, e.g. the DCC-β declines from 0.704 to 0.647 after excluding the U.S. market. This is expected since Table 9 indicates that the U.S. and Brazil markets control 76% of world's soybeans exports and 63.5% of world production. To check whether the conditional correlation is high between the markets that are arguably most informative, I also re-estimate the DCC model for the U.S. and Brazil markets and find a high level of persistency between the two markets: 0.979. This might imply that the informative markets are more integrated, or the conditional correlation is strongest in related markets.

Table 8
VAR-DCC Model Estimation Results for Soybeans Futures Traded in United States, China, Japan, and Brazil

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S., China, Japan, and Brazil futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for soybeans futures includes a) U.S., China, and Japan, b) China and Japan and c) U.S. and Brazil futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	**China**	**Japan**	**Brazil**
Panel A: Mean return equation for the full model				
Constant term	2.14e-03[a]	1.30e-03[a]	1.50e-03[a]	1.88e-03[a]
U.S. market return lag 1	6.21e-04	0.3549[a]	0.4372[a]	0.2029[a]
CHN market return lag 1	-0.0153	-0.1336[b]	-0.0137	-0.0318[a]
JPN market return lag 1	-0.0505[a]	-0.0357[a]	-0.1748[a]	-0.0332
BRA market return lag 1	0.0248	0.0202	0.0232	-0.0927[a]
Panel B: Variance equation for the full model				
Constant term	5.76e-05[a]	5.05e-05[a]	1.00e-04[a]	2.04e-05[a]
GARCH coefficient	0.6109[a]	0.1172[a]	0.2667[a]	0.6643[a]
ARCH coefficient	0.0786[a]	0.0536[b]	0.2199[a]	0.1488[a]
U.S. market volatility	--	0.0606[a]	2.53e-03	0.0573[a]
CHN market volatility	0.1702[a]	--	0.7061[a]	0.0472[a]
JPN market volatility	0.0371[a]	0.0496[a]	--	-2.84e-03
BRA market volatility	0.1294[a]	0.2357[a]	0.2668[a]	--

Panel C: DCC parameters and model characteristics for the full model and reduced model(s)

Countries	α	β	Log-Likelihood	Sample Size
U.S., China, Brazil, and Japan	0.0399[a]	0.7043[a]	7976.86	682
U.S., China, and Japan	0.0204[b]	0.6470[a]	9699.18	1152
China and Japan	0.0115[a]	0.5632[a]	6061.80	1161
U.S. and Brazil	0.0183[a]	0.9799[a]	4023.403	682

Table 9
World Market of Soybeans

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	37.8%	25.7%	28.57	37%	0.00
China	8.1%	22.7%	0.00	0.00	41%
Japan	00.0	3.2%	0.00	0.00	6%
Brazil	25.7%	16.9%	43.8	39%	0.00

Source: Untied States Department of Agriculture (http://www.usda.gov).

For wheat futures traded in U.S., UK, Canada, and China, the return spillover, as presented in Table 10, is significantly unidirectional from U.S. to UK, Canada, and China with a value of 0.077, 0.079, and 0.064, respectively. Stated differently, none of these markets exert a significant price influence on the U.S. market. The results also indicate that the co-movement and spillover effect is not bi-directional between all markets. For example, there is no spillover from Canada to China and vice-versa. The spillover from U.S. to China is uni-directional. However, the co-movement from U.S. to UK is bi-directional, suggesting market liquidity plays an important role in information transmission (UK is a small player in terms of world trade in wheat but has the second most liquid market). The DCC-β for wheat futures traded in U.S., Canada, UK, and China is 0.587, which is lower than the agricultural commodities examined in this study. After excluding the U.S. market that controls 35.3% of world wheat trade (i.e., the most important market: see Table 11), the DCC-β declines to 0.394. I Further check the interaction between the two informative markets (U.S. and Canada) and find that the DCC-β is high and equal to 0.959. This is consistent with the fact that U.S. and Canada control 50% of world wheat trade.

Table 10
VAR-DCC Model Estimation Results for Wheat Futures Traded in United States, Canada, United Kingdom, and China

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S., Canada, UK, and China futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for wheat futures includes a) UK, Canada, and China, and b) U.S. and Canada futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	**Canada**	**United Kingdom**	**China**
Panel A: Mean return equation for the full model				
Constant term	-1.82e-04	6.93e-04[c]	1.37e-04	5.28e-04[a]
U.S. market return lag 1	-0.0442[b]	0.0797[a]	0.0768[a]	0.0644[a]
CAD market return lag 1	-0.0510[b]	1.3041e-03	-0.0410[c]	0.0248
UK market return lag 1	0.0224	-3.8389e-03	0.0540[a]	-0.0209
CHN market return lag 1	-0.0329	-0.1562[a]	-0.0521	-0.0827[a]
Panel B: Variance equation for the full model				
Constant term	2.23e-05[a]	1.42e-04[a]	6.58e-05[a]	2.55e-05[a]
GARCH coefficient	0.7951[a]	0.1115[a]	0.3147[a]	0.5297[a]
ARCH coefficient	0.1334[a]	0.0674[a]	0.2210[a]	0.1711[a]
U.S. market volatility	--	7.12e-03	0.0173[a]	4.55e-03[a]
CAD market volatility	1.76e-03	--	6.79e-03	0.0181[a]
UK market volatility	0.0207[a]	0.1609[a]	--	-0.0180[a]
CHN market volatility	-0.0313[b]	0.0494	0.3719[a]	--
Panel C: DCC parameters and model characteristics for the full model and reduced model(s)				
Countries	α	β	Log-Likelihood:	Sample Size
U.S., UK, Canada, and China	0.0238[a]	0.5869[a]	12379.83	1043
UK, Canada, and China	0.0452[b]	0.394[b]	9490.16	1043
U.S. and Canada	0.0189[a]	0.9592[a]	5687.41	1043

Table 11
World Market of Wheat

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	11.6%	6%	61.7%	35.3%	2.94%
Canada	4.11%	1%	69.8%	14.2%	0.28%
UK	3.1%	2.6%	25.2%	4.78%	1.4%
China	21.8%	20.2%	2.54%	2.7%	0.15%

Source: Untied States Department of Agriculture (http://www.usda.gov).

4.2.2. Metal Futures:

As stated earlier, this study attempts to analyze the importance of breadth of information. Thus it should be noted that the international production and export for metal generally is not dominated by a handful of countries, which suggests that information production may not be concentrated in a single country. In contrast, the U.S. tends to be a dominant player in main agricultural products. For example, the top ten copper producing countries account for 70% of world production, where as the top five corn producing countries account for 80% of world production. Moreover, the total production reaching the export market for copper is a relatively high at 43% compared to only 13% for corn. The implication of the aforementioned statistics is that the interaction between markets is expected to be higher for metal commodities since the information production is more diverse and does not concentrate in one country.

Table 12 displays the results for aluminum futures, traded in U.S., China, and Japan. The Table documents a significant pricing impact of U.S. aluminum futures on the Chinese and Japanese aluminum futures markets with values of 0.320 and 0.539, respectively. However, neither Chinese nor Japanese market has a significant price influence over the U.S. market. The Table also reveals that the volatility linkages between China, the U.S and Japan are bi-directional and the volatility spillover is stronger from China to the U.S. and Japan markets. This observation might be explained by the greater liquidity level in Chinese aluminum futures market.

The DCC-β estimate across aluminum futures markets is highly significant with a value of 0.987. This means that the interaction of these futures markets is intensive. In other words, such high persistence means that shocks can temporarily make the correlation deviate from its long run average, even though the correlation is eventually mean reverting (i.e., the sum of {DCC-β + DCC-α} is less than one). A re-estimated DCC-β for all markets but China shows a decline from 0.987 to 0.979. This might be due to the fact that the information production is not concentrated in any of these markets. Table 13 indicates that the U.S., China, and Japan markets account for only 6.3%, 5.3%, and 3.0% of world's aluminum exports, respectively.

For copper futures, the results of the VAR-DCC model are reported in Table 14. Also note that the U.S. and China are the world's two largest consumers (U.S and China import 14.3% and 17.9% of world copper imports -- see Table 15). The return spillover is only unidirectional from U.S. to China, with no feedback effect. The volatility spillover effect from China into U.S is significant and higher than that from U.S. into China. That is to say, China market has a relatively more significant role in the volatility information flow between the two markets. These findings support the prior work by Fung, Leung, and Xu (2003) who find that the volatility spillover between the U.S. and China for copper futures is stronger from China to the U.S. The DCC-β estimate across copper futures markets is highly significant with a value of 0.991. This means that the two markets are highly correlated.

Table 12

VAR-DCC Model Estimation Results for Aluminum Futures Traded in United States, China, and Japan

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S., China, and Japan futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for aluminum futures includes U.S. and Japan futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	**China**	**Japan**
Panel A: Mean return equation for the full model			
Constant term	2.38e-04	2.89e-04	1.31e-04
U.S. market return lag 1	-0.0885[b]	0.3201[a]	0.5395[a]
CHN market return lag 1	-0.0104	0.0178[a]	0.2069 [a]
JPN market return lag 1	0.0246	2.25e-03	-0.2106[a]
Panel B: Variance equation for the full model			
Constant term	2.26e-05[a]	2.64e-06[a]	1.08e-05[a]
GARCH coefficient	0.7205[a]	0.7280[a]	0.6240[a]
ARCH coefficient	0.0892[a]	0.1745[a]	0.0768[a]
U.S. market volatility		7.81e-03[a]	0.0771[a]
CHN market volatility	0.2988[a]		0.2077[a]
JPN market volatility	0.0109	0.0339[a]	

Panel C: DCC parameters and model characteristics for the full model and reduced model(s)

Countries	α	β	Log-Likelihood	Sample Size
U.S., China, and Japan	6.76e-03[a]	0.9869[a]	10613.36	1147
U.S. and Japan	7.81e-03[a]	0.9796[a]	13920.11	2263

Table 13

World Market of Aluminum

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	6.8%	34%	NA	6.3%	NA
China	27.7%	39%	NA	5.3%	NA
Japan	0.02%	12%	NA	3.0%	NA

Source: U.S. Geological Survey 2007

N/A: Not Available.

Table 14
VAR-DCC Model Estimation Results for Copper Futures Traded in United States and China

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S. and China futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for the full model. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	China
Panel A: Mean return equation for the full model		
Constant term	3.51e-04	5.72e-04[b]
U.S. market return lag 1	-0.0867[a]	0.5842[a]
CHN market return lag 1	0.0285	-0.0570[a]
Panel B: Variance equation for the full model		
Constant term	3.19e-05[a]	1.12e-05[a]
GARCH coefficient	0.8119[a]	0.7547[a]
ARCH coefficient	0.0118[a]	0.0274[a]
U.S. market volatility	--	0.0582[a]
CHN market volatility	0.3014[a]	--
Panel C: DCC parameters and model characteristics for the full model		
α	4.43e-03[a]	
β	0.9911[a]	
Log-Likelihood: 6601.19		
Sample Size : 1204		

Table 15
World Market of Copper

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	4.7%	25.8%	0.00	0.00	14.3%
China	5.95%	22%	0.00	0.00	17.9%

Source: U.S. Geological Survey 2007

For gold futures traded in the U.S., China, and Japan, Table 16 shows that the return co-movement between China and Japan is bi-directional with a stronger return co-movement from China to Japan. Furthermore, there is a strong pricing impact from the U.S. market to the Chinese and Japanese gold markets with a value of 0.729 and 0.829, respectively. The coefficient from Japan to U.S. is 0.133. This might be expected since Table 17 shows that the U.S. market controls 23.2% of world gold trade. In terms of the volatility spillover and co-movement, the three markets are influencing each other with a strong co-movement from China and Japan to the U.S.

The DCC-β estimate for gold futures 0.933 including all markets, but is substantially lower at 0.579 when the U.S. market is excluded. This is consistent with the U.S. being the most important market, has the strongest pricing impact on Chinese and Japanese gold market, and is the most liquid market in terms of daily trading value.

Table 16

VAR-DCC Model Estimation Results for Gold Futures Traded in United States, China, and Japan

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes U.S., China, and Japan futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for gold futures includes China and Japan futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	**China**	**Japan**
Panel A: Mean return equation for the full model			
Constant term	4.54e-04	-1.01e-04	1.61e-04
U.S. market return lag 1	0.0615	0.7297[a]	0.8287[a]
CHN market return lag 1	0.0499	-0.1370[a]	0.2037[a]
JPN market return lag 1	-0.1326[b]	-0.1276[a]	-0.6016[a]
Panel B: Variance equation for the full model			
Constant term	2.67e-04[a]	4.87e-06[b]	9.93e-06[a]
GARCH coefficient	-0.0839	0.8242[a]	0.8450[a]
ARCH coefficient	0.1000[c]	0.0410[b]	9.59e-04
U.S. market volatility	---	0.0237[a]	0.0476[a]
CHN market volatility	0.3449[b]	--	0.0909[a]
JPN market volatility	0.2034[b]	0.0381[a]	--

Panel C: DCC parameters and model characteristics for the full model and reduced model(s)

Countries	α	β	Log-Likelihood	Sample Size
U.S., China, and Japan	0.0337	0.9328[a]	1844.70	212
China and Japan	-0.048[a]	0.5793[a]	1192.67	213

Table 17

World Market of Gold

This table presents the percent of the world's production and consumption. The table also lists the ratio of country's export to its production, the ratio of country's export to the world exports, and the ratio of the country's import to the world imports.

Market	Production % of World total	Consumption % of World total	Country export/Country production	Country export/World Exports	Country import/World imports
U.S.	9.4%	16%	NA	23.2%	13.5%
China	10.9%	8.%	0.00	0.003%	0.00
Japan	0.36%	2%	NA	6.0%	4.1%

Source: U.S. Geological Survey 2007

N/A: Not Available.

4.2.3. Stock Index Futures:

In this section, the return and the volatility linkages as well as the extent of the market interactions across futures markets for India Nifty index and Japan Nikkei 225 are estimated.

Table 18 displays the VAR-DCC results for the Nifty index traded in India and Singapore. The results suggest a strong pricing impact of the Singapore traded Nifty index on the India Nifty index. The Table also indicates the relatively more significant role of Singapore market in the volatility information flow from Singapore market to India since the volatility co-movement effect from Singapore into India is significant, 0.371 and higher than that from India into Singapore, 0.168. These results for the Nifty index are surprising, because it suggests that India does not possess information advantage in the Nifty index. I do not have a satisfactory explanation for this result.

The DCC-β estimate is highly significant for Nifty index with a value of 0.739, showing that the correlation between the two markets during the sample period is time varying with a moderate level of persistency.

For the Nikkei 225 traded in Japan, U.S., and Singapore, Table 19 reports a strong pricing impact of the U.S. on both the Japan and Singapore-traded Nikkei 225 with a value of 0.414 and 0.392, respectively, and from Singapore to that of Japan with a value of 0.144. As for the variance equations, the volatility co-movement from Singaporean market to Japanese market 0.055 is slightly higher than that from Japanese market to Singaporean market 0.047. Volatility spillover between Japan and U.S. markets are also bi-directional with a slightly stronger volatility spillover from U.S. 0.046 to Japan market 0.030. These results suggest that U.S. and Singapore markets are more important for Nikkei 225 in terms of information transmission. As in the Nifty index, the results contradict the typical information advantage of the home market. A partial explanation might be that the U.S. and Singapore have a large and active group of analysts and futures trading firms. Alternatively, there might be obstacles in trading, preventing information to be fully transferred.

The DCC-β parameter for Nikkei 225, is highly significant with a value of 0.968, showing that the correlation over the three markets is time varying with high level of persistency compared to Nifty index, 0.739. This might be explained by the Nifty index being a narrow-based index futures rather than a global one relative to Nikkei 225. Stated differently, being an index of global interest, Nikkei 225 attracts more market interactions.

The DCC-β estimate for Nikkei 225 traded in Japan, U.S., and Singapore decline from 0.968 to 0.960 when excluding the home market (i.e., Japan). That is, when the home market is dropped, the correlation persistency does not drop off much, again suggesting a less important information role of the Japanese market.

Table 18
VAR-DCC Model Estimation Results for the S&P CNX Nifty Index Futures Traded in Singapore and India

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes India and Singapore futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for the full. a, b, and c refer to significance at 1,5,10% levels, respectively.

	Singapore	**India**
Panel A: Mean return equation for the full model		
Constant term	1.0576e-03[a]	1.2960e-03[a]
SGP market return lag 1	0.0514[a]	0.3762[a]
IND market return lag 1	0.0678[a]	-0.2391[a]
Panel B: Variance equation for the full model		
Constant term	5.7085e-05[a]	1.0268e-05[a]
GARCH coefficient	0.5650[a]	0.5783[a]
ARCH coefficient	0.3296[a]	0.1837[a]
SGP market volatility		0.3708[a]
IND market volatility	0.1684[a]	
Panel C: DCC parameters and model characteristics for the full model		
α	0.2193[a]	
β	0.7398[a]	
Log- Likelihood	3702.49	
Sample size	652	

Table 19
VAR-DCC Model Estimation Results for the Nikkei 225 Futures Traded in United States, Singapore, and Japan

The table shows the estimates of the VAR-DCC model. Panel A shows the estimates of the mean return equations for the full model (i.e., all markets that trade the underlying commodity). The full model includes Japan, U.S., and Singapore futures markets. Panel B shows the estimates for the variance equations for the full model. Panel C shows the DCC parameters and model characteristics for both the full model and the reduced model. The reduced model for Nikkei 225 index futures includes U.S. and Singapore futures markets. a, b, and c refer to significance at 1,5,10% levels, respectively.

	United States	Singapore	Japan
Panel A: Mean return equation for the full model			
Constant term	3.4422e-04 [b]	2.1338e-04 [a]	1.7165e-04 [a]
U.S. market lag 1	-0.0704 [a]	0.3918 [a]	0.4136 [a]
SGP market lag 1	-0.0137	-0.3267 [a]	0.1435 [a]
JPN market lag 1	0.0423[a]	0.0839 [a]	-0.3903 [a]
Panel B: Variance equation for the full model			
Constant term	3.9540e-06 [a]	-4.7437e-08 [a]	4.1492e-07
GARCH coefficient	0.8766 [a]	0.8851[a]	0.8624[a]
ARCH coefficient	0.0798 [a]	0.0410 [a]	0.0410[a]
U.S. market volatility spillover		0.0343 [a]	0.0464[a]
SGP market volatility spillover	7.2378e-03[b]		0.0553[a]
JPN market volatility spillover	0.0301[a]	0.0465 [a]	

Panel C: DCC parameters and model characteristics for the full model and reduced model(s)

Countries	α	β	Log-Likelihood	Sample Size
Japan, U.S., and Singapore	0.0313 [a]	0.9679 [a]	24486.25	2475
U.S. and Singapore	0.0300 [a]	0.9604 [a]	14471.00	2475

4.3. Discussions of Overall Results of the DCC Model

In general, the strength of interaction among the futures markets is higher for metal commodities than for agricultural futures commodities; for example, the DCC-β estimate for aluminum, copper, and gold is high with a value of 0.987, 0.991, and 0.933, respectively, whereas the DCC-β for coffee, corn, soybeans, and wheat is moderate with a value of 0.635, 0.678, 0.704, and 0.587, respectively. One possible explanation is that the metal production is not concentrated in a few countries, while the U.S. has a strong influence in worldwide agricultural export. The relatively high interaction in metals, captured by their high DCC-β, is in agreement with the breadth of information being a relevant factor in the extent of market interactions. For metals, the information linkage also tends to be bi-directional. This would be consistent with the notion that when the information required to price the metal commodities is more diverse, the degree of market interaction is greater.

The results from the mean returns and variance equations indicate that markets with the greater information production have an important role in returns and volatility spillover across futures markets. For example, U.S. controls 66.5% of the world corn trade. Thus, the prices in international export market for corn are mostly determined by U.S. market. Indeed, I find that, for a country whose exports dominate the world trade market tends to be the market that has the leadership role in return transmission and tends to be more informative. However, for the two stock indices examined here, the results suggest that the home country is not the most influential, a curious result that deserves further investigation in the future.

The informative markets play a substantial role in the interaction between markets. Specifically, I find that the persistency in conditional correlation is lower when the informative market(s) is excluded from the estimation. For example, the DCC-β across corn futures markets in the U.S., UK, China, and Japan declines from 0.678 to 0.353 when the U.S. market is excluded. This suggests that the breadth of information plays a role in the degree of interaction.

The results also indicate that the interaction between the more informative markets is significantly high. For example, the persistence of dynamic conditional correlation process for wheat futures traded in U.S. and Canada (i.e., the most informative markets) is high and equal to 0.959. As another example, the DCC-β between the most informative markets in soybeans -- U.S. and Brazil -- reflects a high level of persistency: 0.979. This implies that the dynamic conditional correlation is greater in closely related markets.

4.4. Results for Price Discovery in Futures Markets:

This section presents the estimates of contribution to price discovery. Note that the model -- Vector Error Correction Models given by equations (12) and (13)—can only be applied to markets trading at the same time. Therefore, the results here are performed on a small set of commodities. Table 20 presents the results. The market that has the lowest adjustment coefficient (τ) has the largest contribution to the price discovery process, which is consistent with Schwarz and Szakmary, 1994; Korczak and Phylaktis, 2007. Table 20 also provides a summary of the co-integrating vectors that are estimated using the Johansen methodology.

For wheat futures that are traded on MGE of U.S. and WCE of Canada, the adjustment coefficients are significant; this implies that MGE and WCE contribute to price discovery. The adjustment coefficient for U.S. has a negative sign -0.0003 compared to a positive sign 0.0097 for the Canadian market. The Canadian share in price discovery is trivial 2.5%, showing the price impact of Canadian prices is less than that of the U.S. prices. These results are consistent with the VAR-DCC findings that U.S. has a relatively more significant role in the volatility information flow and pricing impact in wheat futures markets.

For aluminum futures, the adjustment coefficients for China and Japan are significant at the 1% level, which implies a bi-directional response to deviations from the equilibrium. Thus, both markets contribute to price discovery. Table 20 shows that the adjustment coefficient for China market is negative and significant -0.0011, while the adjustment coefficient of Japan is positive and significant 0.0390. The share of China in price discovery is 97.4%, showing that China has a greater futures price leadership over the Japan market. This means that Japanese prices are influenced much more by Chinese prices than the Chinese prices are influenced by Japanese prices. These findings are in agreement with the VAR-DCC results that China has a relatively more significant role in the volatility information flow and pricing impact.

For the Nifty index, the adjustment coefficients for India Nifty index and Singapore traded Nifty index are significant at the level of 10%. This finding implies that Singaporean prices respond to deviations from the Indian prices, and Indian prices respond to deviations from the Singaporean prices. Both Singaporean and India markets contribute to price discovery. Specifically, the adjustment coefficient for India Nifty index has a negative sign -0.0602 compared to a positive 0.0017 for the Singaporean market. On the basis of these adjustment coefficients, the Singapore share in the price discovery process using equation (14) is equal to 97.2%. The extent to which Indian prices respond to Singaporean prices is substantial and implies that Singapore has a larger role in the price discovery process of the Nifty index market. This finding is consistent with the earlier VAR-DCC results that Singapore has a relatively more significant role in the volatility information flow and pricing impact. In both indices, the home country does not appear to have information advantage. Possible but not completely satisfactory explanations are that these home countries have lower liquidity or greater trading obstacles.

Table 20

Vector Error Correction Models Coefficients and the i[th] Market Contribution to the Price Discovery Process

Contract	Cointegration equation		Error correction term coefficient		i[th] market contribution in price discovery		i[th] market contribution in price discovery	
Wheat	$\upsilon^{U.S.}$	1.000	$\tau^{U.S.}$	-0.00025[a]	$\Theta_{CAD\rightarrow U.S.}=\frac{\lvert\tau^{U.S.}\rvert}{\lvert\tau^{U.S.}\rvert+\tau^{CAD}}$	0.025	$\Theta_{U.S.\rightarrow CAD}=\frac{\tau^{CAD}}{\lvert\tau^{U.S.}\rvert+\tau^{CAD}}$	0.975
	υ^{CAD}	-0.851[c]	τ^{CAD}	0.00969[a]				
Aluminum	υ^{CHN}	1.000	τ^{CHN}	-0.00105[a]	$\Theta_{JPN\rightarrow CHN}=\frac{\lvert\tau^{CHN}\rvert}{\lvert\tau^{CHN}\rvert+\tau^{JPN}}$	0.026	$\Theta_{CHN\rightarrow JPN}=\frac{\tau^{JPN}}{\lvert\tau^{CHN}\rvert+\tau^{JPN}}$	0.974
	υ^{JPN}	-0.656[b]	τ^{JPN}	0.038977[a]				
S&P CNX Nifty Index	υ^{IND}	1.000	τ^{IND}	-0.0602[c]	$\Theta_{SGP\rightarrow IND}=\frac{\lvert\tau^{IND}\rvert}{\lvert\tau^{IND}\rvert+\tau^{SGP}}$	0.972	$\Theta_{IND\rightarrow SGP}=\frac{\tau^{SGP}}{\lvert\tau^{IND}\rvert+\tau^{SGP}}$	0.028
	υ^{SGP}	-1.006[a]	τ^{SGP}	0.0017[c]				

a, b, and c refer to significance at 1,5,10% levels, respectively.

5. Conclusions

This paper analyzes the interaction across futures markets for a large set of commodities and financial futures. I hypothesize that the more diverse the information production, the more likely there is inter-market information transfer. The analysis utilizes the dynamic conditional correlation developed by Engle (2002) to examine the interaction across world futures markets and commodities. Specifically, the study estimates the time varying correlation between daily futures market returns and investigates the returns and volatility linkages for different groups of commodity and financial futures. The study is more comprehensive than prior literature in terms of the number of markets and commodities; this allows a richer set of testing.

The primary finding is that the market interactions are relatively high for commodities where information production is more diverse (metal commodities), and lower for commodities where information is more concentrated (agricultural commodities). Furthermore, the market interaction is lower after excluding the most informative market(s) from the model. For example, the DCC-β across corn futures markets in the U.S., UK, China, and Japan is 0.678; in contrast, DCC-β excluding the U.S. (the most informative one) is much lower at 0.353.

The study also estimates the contribution of futures market to price discovery by utilizing the Vector Error Correction Models. Examining price discovery deepens our understanding of price leadership across futures markets. For instance, I find that Canada's share in price discovery for wheat futures is only 2.5%, while that of the U.S. is much greater.

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Appendices

Appendix 1: Commodity and Financial Futures Contract Specifications

Appendix 1-A: Coffee Futures Commodity Contract Specifications

	Coffee Futures			
Markets	U.S.	UK	Brazil	Japan
Trading Market	New York Mercantile Exchange (NYMEX/ CSCE)	LIFFE CONNECT® (London)	Brazilian Mercantile & Futures Exchange (BM&F)	Tokyo Grain Exchange (TGE)
Unit	U.S. cents per pounds.	U.S. dollars per tonne	U.S. dollars per 60 kilogram	Japanese Yen per bag (69 kilograms)
Contract Size	37,500 pounds	Five tonnes	6,000 kilograms	50 bags (3,450 kilograms)
Deliverable Grades		up to 150 defects per 500 g at basis; 151 - 250 defects per 500 g at a discount of U.S.$15/ tonne; 251 - 350 defects /500 g at a discount of U.S.$30/ tonne; or 351 - 450 defects per 500 g at a discount of U.S.$45/ tonne.	Green coffee beans produced in Brazil, variety *coffea arabica*, type six or better, good cup or better,	The following washed arabica coffee satisfying the terms and conditions stipulated in the Exchange rules: Mexico (Prime Washed), Guatemala (Extra Prime Washed) El Salvador (Central Standard), Costa Rica (Hard Bean) Honduras (High Grown), Nicaragua (Strictly High Grown)
Last Trading Day	One business day prior to last notice day.	Last business day of the delivery month at 12:30	The sixth business day proceeding the last day of the delivery month.	Ten business days prior to the last business day of the delivery month.
Trading Hours (Local)	8:30 am – 2:00 pm(Mon – Fri)	08:00 - 17:30	10:00 am – 15:30 pm	9:30 am - 11:30 am, 1:30 pm - 3:30 pm
Contract Months	Mar, May, Jul, Sept, Dec for the next 23 months	Jan, Mar, May, Jul, Sept, Nov	Mar, May, Jul, Sept, Nov	Jan, Mar, May, Jul, Sept, Nov

Contract specification is based on availability on Dec. 2008

Appendix 1-B: Corn Futures Commodity Contract Specifications

	Corn Futures			
Markets	U.S.	UK	Japan	China
Trading Market	Chicago Board of Trade (CBOT)	LIFFE CONNECT® (London)	Kansai Commodity Exchange (KCX)	Dalian Commodity Exchange (DCE)
Unit	Cents per bushels	Euro per metric tone	Japanese Yen per ton	China Yuan per metric ton
Contract Size	5,000 bushels	50 metric tons	50 ton	10 metric tons
Deliverable Grades	No. 2 Yellow at par, No. 1 yellow at 1 1/2 cents per bushel over contract price, No. 3 yellow at 1 1/2 cents per bushel under contract price	Yellow and/or red corn, of sound, fair and merchantable quality of the following standard: Moisture (15%-15.5%) Broken grain (4%- 10%) Sprouted grain (2.5%-6%) Grain admixture (4%- 5%) Other impurities (1%- 3%)	Yellow corn produced in U.S.	Corn at Par is Subject to DCE Corn Delivery Quality Standard
Last Delivery Day	Second business day following the last trading day of the delivery month.	The fifth calendar day of the delivery month. If not a business day, then the first following business day	Last business day two months prior to the delivery month. In December, the last trading day is the third to last Business day.	Second day after the last trading day of the delivery month
Trading Hours (Local)	9:30 am - 1:15 pm	10:45 am - 18.30 pm	9:20, 10:20, 11:20 am 1:20, 2:20, 3:20 pm	9:00 am - 11:30 am, 1:30 pm - 3:00 pm
Contract Months	Dec, Mar, May, Jul, Sep	Nov, Jan, Mar, Jun, Aug	Feb, Apr, Jun, Aug, Oct, Dec	Jan, Mar, May, July, Sep, Nov

Contract specification is based on availability on Dec. 2008

Appendix 1-C: Soybeans Futures Commodity Contract Specifications

	Soybeans Futures			
Markets	U.S.	Japan	China	Brazil
Trading Market	Chicago Board of Trade (CBOT)	Tokyo Grain Exchange (TGE)	Dalian Commodity Exchange (DCE)	Brazilian Mercantile & Futures Exchange (BM&F)
Unit	U.S. Cents per bushel	Japanese Yen per tonne	Chinese Yuan per Ton	U.S. dollars per 60 kilogram
Contract Size	5,000 bushels	50 Metric Tons	10 Ton	27 tonnes
Deliverable Grades	No. 2 Yellow at par, No. 1 yellow at 6 cents per bushel over contract price and No. 3 yellow at 6 cents per bushel under contract price	No. 2 yellow soybeans produced in the U.S. and yellow soybeans produced in the Federative Republic of Brazil and the Republic of Paraguay that satisfy the terms and conditions stipulated in the Exchange Rules	No. 3 yellow with purity rate above 91% and No. 1 yellow with purity rate above 96%, No. 2 yellow with purity 93.5%, No. 4 yellow with purity above 88.5%	The soybeans shall be physiologically developed, healthy, clean, dry and free from foreign odors which are inappropriate to the commodity
Last Trading Day	The business day prior to the 15th calendar day of the contract month.	Fifteenth calendar day of the delivery month; if that day is not a business day, then the last trading day is moved up to the nearest business day.	10th Trading Day of the Delivery Month	The ninth business day proceeding the first day of the delivery month. On that day, neither opening of new short positions nor day trading shall be allowed
Trading Hours (Local)	9:30 am - 1:15 pm	10:00 am - 11:30 am; 01:00 pm - 2:30 pm	9:00 am - 11:30 am 1:30 pm - 3:00 pm	9:00 am – 14:30
Contract Months	Sep, Nov, Jan, Mar, May, Jul, Aug	Feb, Apr, Jun, Aug, Oct, Dec	Jan, Mar, May, July, Sep, Nov	Mar Apr, May, Jun, Jul, Aug, Sep, Nov.

Contract specification is based on availability on Dec. 2008

Appendix 1-D: Wheat Futures Commodity Contract Specifications

	Wheat futures			
Markets	U.S.	Canada	UK	China
Trading Market	Minneapolis Grain Exchange (MGE)	Winnipeg Commodity Exchange (WCE)	LIFFE CONNECT® (London)	Zhengzhou Commodity Exchange (ZCE)
Unit	Cents per bushel	Canadian dollar per tone	U.S. Dollars per tone	Chinese Yuan per ton
Contract Size	5,000 bushels	20 tonnes.	100 tonnes	10 tons
Deliverable Grades	No. 2 or better Northern Spring Wheat with a protein content of 13.5% or higher, with 13% protein deliverable at a discount.	Any unlicensed variety of red wheat or licensed variety of red wheat as defined by the Canadian Grain Commission	Sound and sweet and in good condition and to contain no more than 3% heat damage. Natural weight to be not less than 72.5 kg per hectoliter. Moisture content not to exceed 15%	2nd grade strong gluten wheat
Last Trading Day	The business day preceding the fifteenth calendar day of that contract month	The fifteenth calendar day of the delivery month.	The 23rd calendar day of delivery month	The seventh business day prior to the last trading day in the contract month
Trading Hours (Local)	10:30 am - 2:15 pm	9:30 am – 1:15 pm	10:00 am – 04:15 pm	9:00 am -11:30 pm 1:30 pm – 3:00 pm
Contract Months	Mar, May, Jul, Sept, Dec	Mar, May, Jul, Oct, Dec	Jan, Mar, May, Jul, Nov	Jan, Mar, May, Jul, Sep, Nov

Contract specification is based on availability on Dec. 2008

Appendix 1-E: Aluminum Futures Commodity Contract Specifications

	Aluminum Futures		
Markets	U.S.	Japan	China
Trading Market	New York Mercantile Exchange (NYMEX/ COMEX)	The Tokyo Commodity Exchange (TCE)	Shanghai Futures Exchange (SHFE)
Unit	U.S. dollar per pound	Japanese Yen per kg	China Yuan per ton
Contract Size	44,000 pounds	10 tonnes	5 ton
Deliverable Grades	Aluminum of 99.7% purity with a maximum iron content of 0.20% and a maximum silicon content of 0.10%.	Aluminum of minimum 99.70% purity with maximum permissible iron content 0.20% and silicon content 0.10%	Aluminum 99.7% purity
Last Trading Day	The third to last business day of the delivery month.	The third business day prior to the delivery day	The 15th day of the spot month (postponed if legal holidays)
Trading Hours (Local)	7:50 am - 1:15 pm (Mon – Fri)	9:00 am - 11:00 am , 12:30 pm - 3:30 pm	9:00 am - 11:30 am, 1:30 pm - 3:00 pm
Contract Months	Four consecutive months	All even months within a year	January to December

Contract specification is based on availability on Dec. 2008

Appendix 1-F: Copper Futures Commodity Contract Specifications

	Copper Futures	
Markets	U.S.	China
Trading Market	New York Mercantile Exchange (NYMEX/ COMEX)	Shanghai Futures Exchange (SHFE)
Unit	U.S. cents per pound.	Chinese Yuan per ton
Contract Size	25,000 pounds.	5 ton
Deliverable Grades	Grade 1 electrolytic copper conforming to the specification as to chemical and physical requirements, as adopted by the American Society for Testing and Materials, and of a brand approved and listed by the Exchange	Standard Copper Cathode, Copper+Silver≥99.95%, High grade Copper or the LME Registered Brand
Last Delivery Day	The first delivery day is the first business day of the delivery month; the last delivery day is the last business day of the delivery month.	16th –20th of the spot month (postponed in case of legal holidays)
Trading Hours (Local)	8:10 am - 1:00 pm (Mon – Fri)	9:00 am - 11:30 am, 1:30 pm - 3:00 pm
Contract Months	Trading is conducted for delivery during the current calendar month and the next 23 consecutive calendar months.	January to December

Contract specification is based on availability on Dec. 2008

Appendix 1-G: Gold Futures Commodity Contract Specifications

	Gold Futures		
Market	U.S.	Japan	China
Trading Market	New York Mercantile Exchange (NYMEX/ COMEX)	The Tokyo Commodity Exchange (TCE)	Shanghai Futures Exchange (SHFE)
Unit	U.S. dollars per troy ounce.	Japanese Yen per gram	China Yuan per gram
Contract Size	100 troy ounces.	1 kilogram	1 kilogram
Deliverable Grades	Not less than 0.995 fineness,	Gold of minimum 99.99% fineness	Gold with fineness not less than 99.95%
Last Trading Day	The close of business on the third to last business day of the maturing delivery month.	The third business day preceding the Delivery Day	The 15th day of the spot month (postponed if legal holidays)
Trading Hours (Local)	8:20 am - 1:30 pm (Mon – Fri)	9:00 am - 11:00 am; 12:30 pm - 5:30 pm	9:00 am - 11:30 am 1:30 pm - 3:00 pm
Contract Months	Any Feb, Apr, Aug, and Oct falling within a 23-month period; and any Jun and Dec falling within a 60-month period beginning with the current month.	All even months within a year	January to December

Contract specification is based on availability on Dec. 2008

Appendix 1- H: Financial Futures Contract Specifications

	S&P CNX Nifty Index		Nikkei 225		
Markets	Singapore	India	U.S.	Japan	Singapore
Trading market	Singapore Exchange (SGX)	National Stock Exchange of India (NSI)	Chicago Mercantile Exchange (CME)	***Osaka Securities Exchange (OSE)***	Singapore Exchange (SGX)
Unit	points	points	points	points	points
Contract Size	$ 2 times S&P CNX Nifty Index	INR 100 times S&P CNX Nifty Index	$5 times the Nikkei Stock Average	Nikkei 225 x ¥1,000	¥500 x Nikkei 225 Index Futures Price
Settle method	Cash settlement	Cash settlement	Cash Settled	Cash Settlement	Cash settlement
Trading hours (Local)	9:00 am – 18:15	9:55-15:30	8:00 am to 3:15 pm	9:00 - 11:00, 12:30 - 15:10, 16:30 - b19:00	7:45 am – 2:30 pm
Contract months	2 nearest serial months and 4 quarterly months on March, June, September and December cycle.	3-month trading cycle - the near month (one), the next month (two) and the far month (three).	Four months in the March Quarterly Cycle. Mar, Jun, Sep, Dec.	5 months in the March quarterly cycle: Mar, Jun, Sep, Dec	3 nearest serial months & 5 nearest quarterly months

Contract specification is based on availability on Dec. 2008

Appendix 2: Conversion Unit

The table consolidates the quotation units for the data series into U.S unit and adjusts the daily prices to U.S. dollars using daily exchange rate provided by Wharton Research Data Services (WRDS).

Market	Home Market Quotation Unit	Conversion Factor
	Agricultural Futures: Coffee Contracts	
U.S.	U.S. cents per bound	$\frac{1}{100\,cents/U.S.\$}$
UK	U.S. dollar per tonne	$0.0045\ tonne\ /\ lb$
Brazil	U.S. dollar per 60 kg	$\frac{1}{60} \times 0.45\ kg\ /\ lb$
Japan	Japanese Yen per 69 kg	$\frac{1}{69} \times \frac{0.45\ kg/lb}{Exchange\ rate\ Yen/U.S.\$}$
	Agricultural Futures: Corn Contracts	
U.S.	U.S. cents per bushels	$\frac{1}{100\ cents/U.S.\ \$}$
UK	Euro per tonne	$\frac{0.025\ tonne/corn\ bushel}{Exchange\ rate\ Euro/U.S.\$}$
China	Chinese Yuan per tonne	$\frac{0.025\,tonne/corn\,bushel}{Exchange\,rate\,Yuan/U.S.\$}$
Japan	Japanese Yen per ton	$\frac{0.028\,ton/corn\,bushel}{Exchange\,rate\,Yen/U.S.\$}$
	Agricultural Futures: Soybeans Contracts	
U.S.	U.S. cents per bushels	$\frac{1}{100\ cents/U.S.\ \$}$
China	Chinese Yuan per ton	$\frac{0.03\,ton/soybeans\,bushel}{Exchange\,rate\,Yuan/U.S.\$}$
Japan	Japanese Yen per tonne	$\frac{0.027\ tonne/soybeans\ bushel}{Exchange\ rate\ Yen/U.S.\$}$
Brazil	U.S. dollar per 60 kg	$\frac{1}{60} \times 27.22\ kg/soybeans\ bushel$
	Agricultural Futures: Wheat Contracts	
U.S.	U.S. cents per bushels	$\frac{1}{100\ cents/U.S.\ \$}$
Canada	Canadian Dollar per tonne	$\frac{0.027\ tonne/wheat\ bushel}{Exchange\ rate\ CD/U.S.\$}$
UK	GBP per tonne	$\frac{0.027\ tonne/wheat\ bushel}{Exchange\ rate\ GBP/U.S.\$}$
China	Chinese Yuan per ton	$\frac{0.03\,ton/wheat\,bushel}{Exchange\,rate\,Yuan/U.S.\$}$
	Metal Futures: Aluminum Contracts	
U.S.	U.S. dollar per pound	--
China	Chinese Yuan per ton	$\frac{0.0005\ ton/lb}{Exchange\ rate\ Yuan/U.S.\$}$
Japan	Japanese Yen per Kg	$\frac{0.45\,kg/lb}{Exchange\,rate\,Yen/U.S.\$}$
	Metal Futures: Gold Contracts	
U.S.	U.S. dollar per troy ounce	--
China	Chinese Yuan per gram	$\frac{31.103\ gram/ounce}{Exchange\ rate\ Yuan/US\$}$
Japan	Japanese Yen per gram	$\frac{31.103\ gram/ounce}{Exchange\ rate\ Yen/US\$}$

Appendix 2 continued

Market	Home Market Quotation Unit	Conversion Factor
Metal Futures: Copper Contracts		
U.S.	U.S. cents per pound	$\frac{1}{100\,cents/U.S\$}$
China	Chinese Yuan per ton	$\frac{0.0005\ ton/lb}{Exchange\ rate\ Yuan/U.S.\$}$
Financial Futures: S&P CNX (India) Nifty Index Contracts		
Singapore	points	$\$2 \times index$
India	points	$\frac{100 \times index}{Exchange\ rate\ INR/U.S.\$}$
Financial Futures: Nikkei 225 Contracts		
U.S.	points	$\$5 \times index$
Singapore	points	$\frac{500 \times index}{Exchange\ rate\ Yen/U.S.\$}$
Japan	points	$\frac{1000 \times index}{Exchange\ rate\ Yen/U.S.\$}$

Appendix 3: Trading Hours in Greenwich Mean Time for Futures Markets

Nikkei 255 Index

Countries	Times (GMT)	U.S.	Singapore	Japan
U.S.	14:00 – 21:15	--		
Singapore	23:55 - 06:25	No	--	
Japan	00:00 - 02:00 03:30 - 06:10	No	Y	--

S&P CNX (India) Nifty Index

Countries	Times (GMT)	Singapore	India
Singapore	02:00-10:15	--	
India	03:55-10:30	Y	--

Gold

Countries	Times (GMT)	U.S.	China	Japan
U.S.	13:20 – 18:30	--		
China	01:00 - 03:30 05:30 – 07:00	No	--	
Japan	00:00 - 02:00 03:30 - 06:30	No	Y	--

Aluminum

Countries	Times (GMT)	U.S.	China	Japan
U.S.	12:50 – 18:15	--		
China	01:00 - 03:30 05:30 – 07:00	No	--	
Japan	00:00 - 02:00 03:30 - 06:30	No	Y	--

Copper

Countries	Times (GMT)	U.S.	China
U.S.	12:50 – 18:15	--	
China	01:00 - 03:30 05:30 – 07:00	No	--

Wheat

Countries	Times (GMT)	U.S.	Canada	UK	China
U.S.	13:30 –17:15	--			
Canada	13:30 –17:15	Y	--		
UK	10:00 – 16:15	Y	Y	--	
China	01:00 – 03:30 05:30 – 07:00	No	No	No	--

Coffee

Countries	Times (GMT)	U.S.	Japan	UK	Brazil
U.S.	13:30 – 19:00	--			
Japan	00:30 - 01:30 04:30 - 06:30	No	--		
UK	08:00 - 17:30	Y	No	--	
Brazil	12:00 - 17:30	Y	No	Y	--

Corn

Countries	Times (GMT)	U.S.	UK	China	Japan
U.S.	15:30 – 19:15	--			
UK	10:45 - 18:30	Y	--		
China	01:00 - 03:30 05:30 – 07:00	No	No	--	
Japan	00:30 - 02:00 04:00 - 06:00	No	No	Y	--

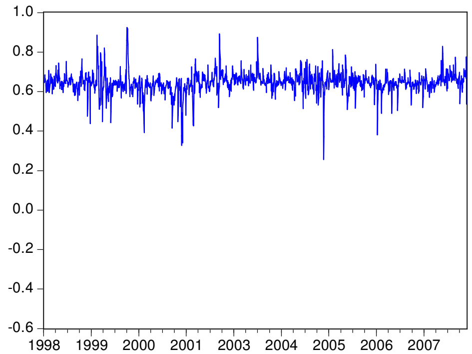
Soybeans

Countries	Times (GMT)	U.S.	China	Japan	Brazil
U.S.	15:30 – 19:15	--			
China	01:00 - 03:30 05:30 – 07:00	No	--		
Japan	01:00 - 03:30 04:00 - 05:30	No	Y	--	
Brazil	13:00 - 18:30	Y	No	No	--

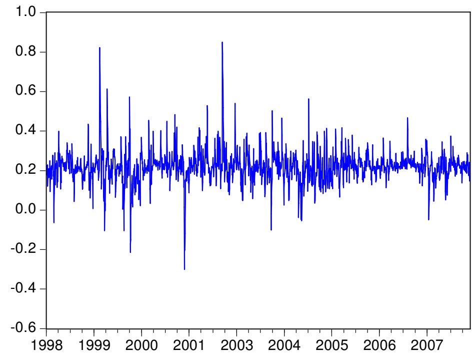
No: There is no overlapping in trading hours Y: There is overlapping in timing

Appendix 4: Dynamic Conditional Correlation Plots

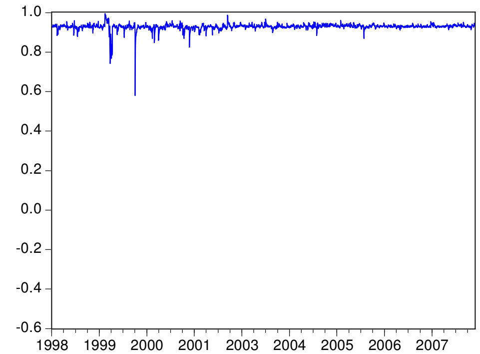
Figure 1: Time-Varying Correlations between Daily Futures Market Returns for Coffee Futures



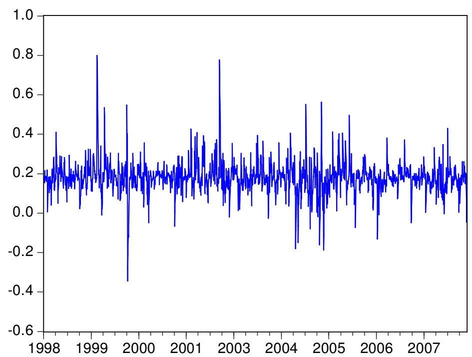
Coffee: U.S. and UK



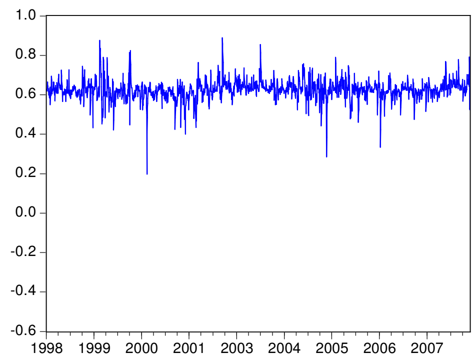
Coffee: U.S. and Japan



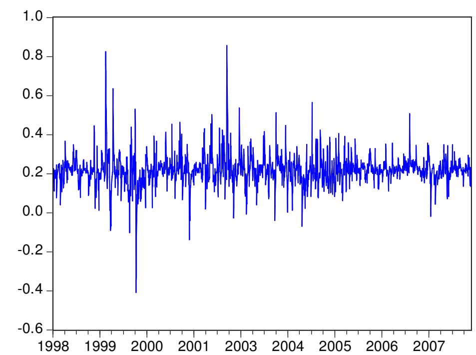
Coffee: U.S. and BRA



Coffee: UK and Japan

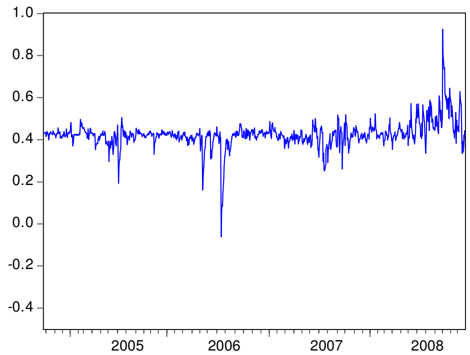


Coffee: UK and BRA

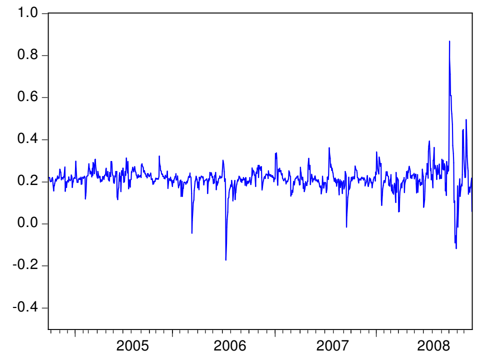


Coffee: BRA and Japan

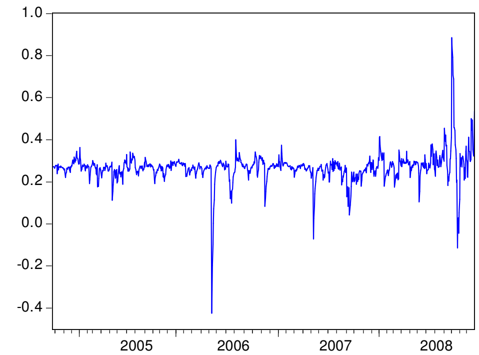
Figure 2: Time-Varying Correlations between Daily Futures Market Returns for Corn Futures



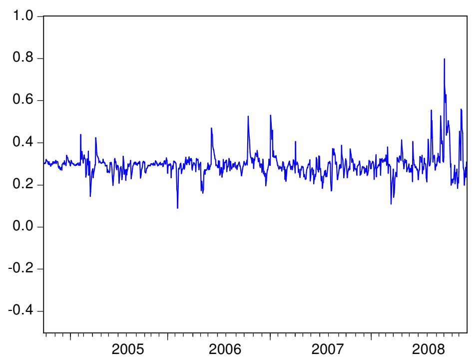
Corn: U.S. and UK



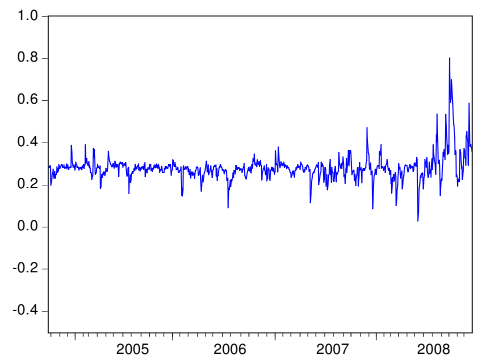
Corn: U.S. and Japan



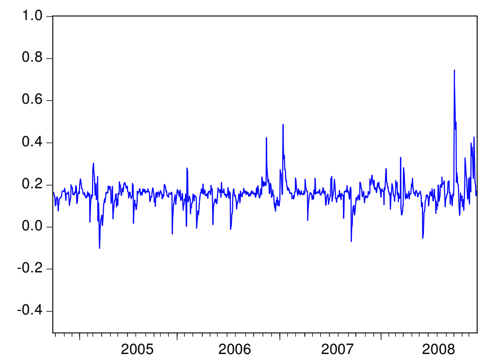
Corn: UK and Japan



Corn: U.S. and China

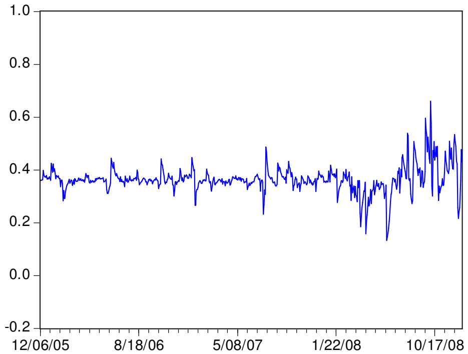


Corn: UK and China

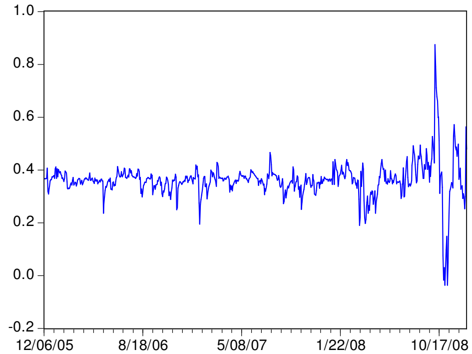


Corn: China and Japan

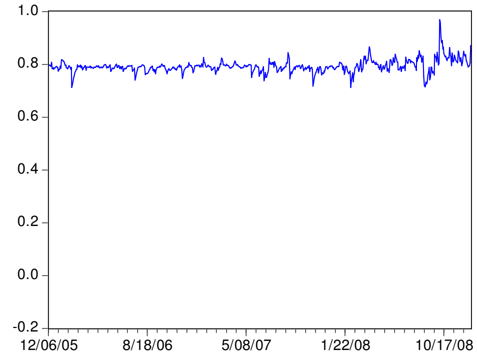
Figure 3: Time-Varying Correlations between Daily Futures Market Returns for Soybeans Futures



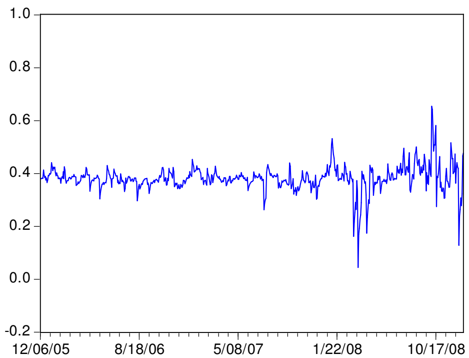
Soybeans: U.S. and China



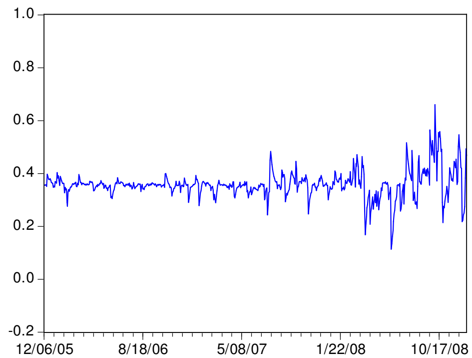
Soybeans : U.S. and Japan



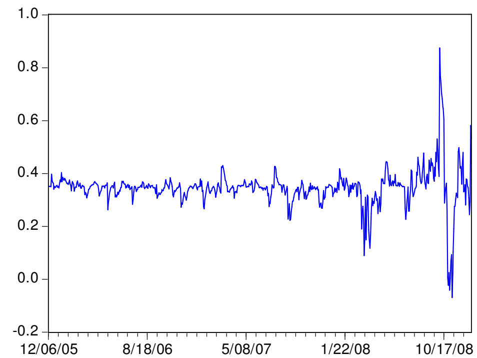
Soybeans : U.S. and Brazil



Soybeans : China and Japan



Soybeans : China and Brazil



Soybeans : Japan and Brazil

Figure 4: Time-Varying Correlations between Daily Futures Market Returns for Wheat Futures

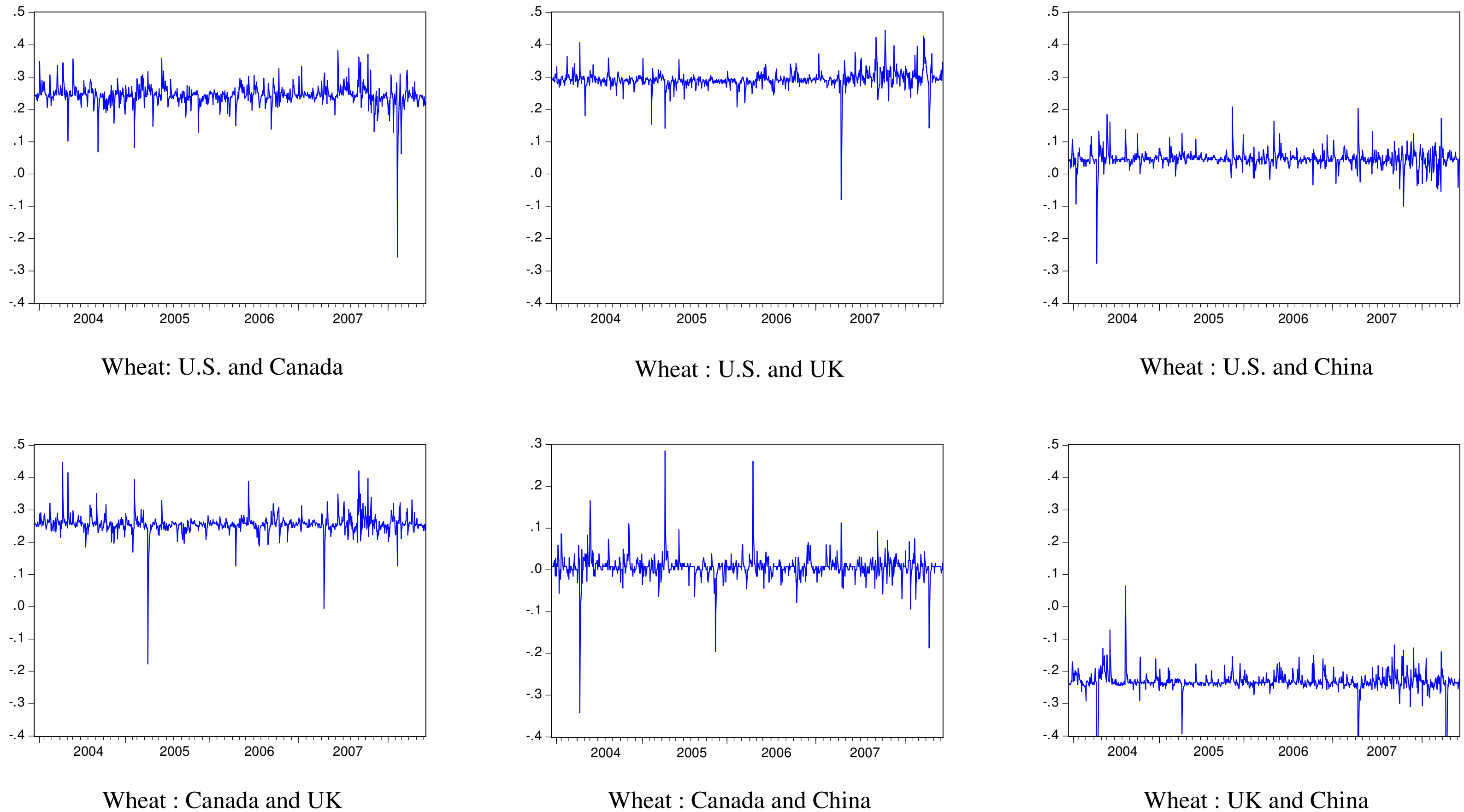
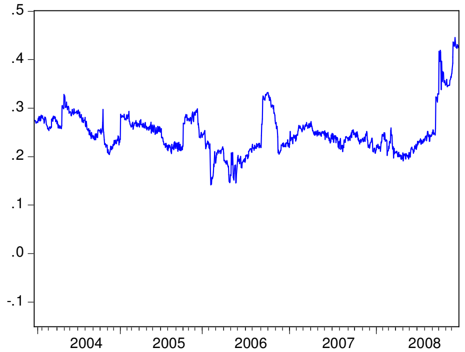
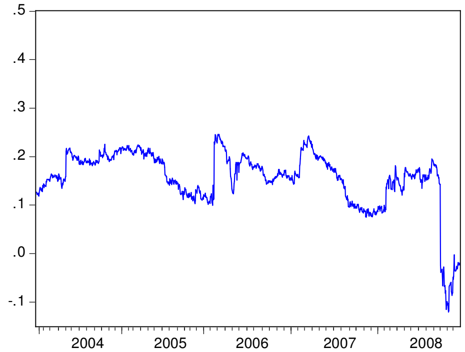


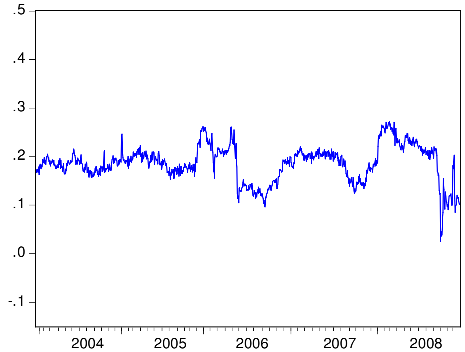
Figure 5: Time-Varying Correlations between Daily Futures Market Returns for Aluminum Futures



Aluminum: U.S. and China

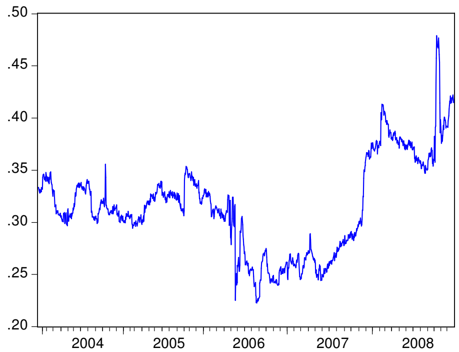


Aluminum: U.S. and Japan



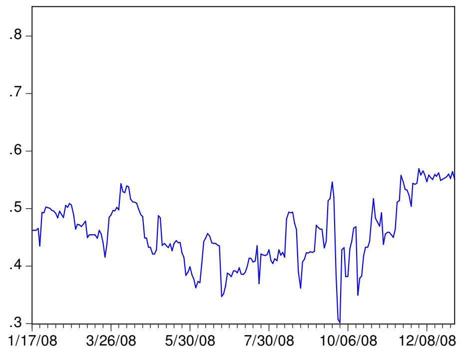
Aluminum: China and Japan

Figure 6: Time-Varying Correlations between Daily Futures Market Returns for Copper Futures

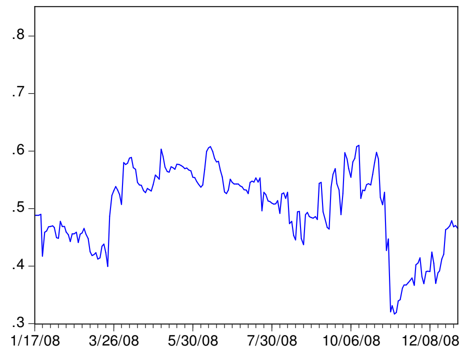


Copper: U.S. and China

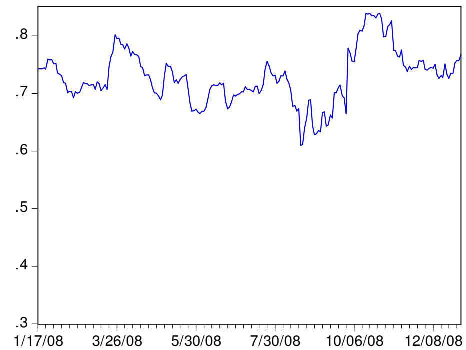
Figure 7: Time-Varying Correlations between Daily Futures Market Returns for Gold Futures



Gold: U.S. and China

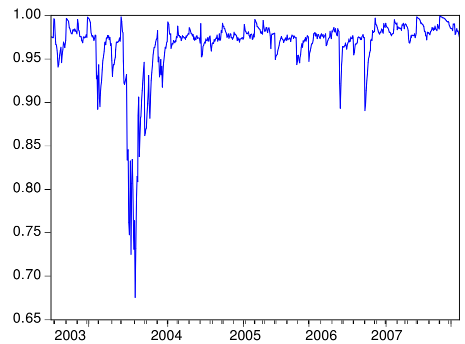


Gold: U.S. and Japan



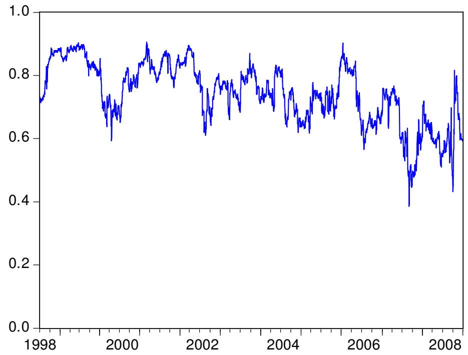
Gold: China and Japan

Figure 8: Time-Varying Correlations between Daily Futures Market Returns for S&P CNX Nifty Index Futures

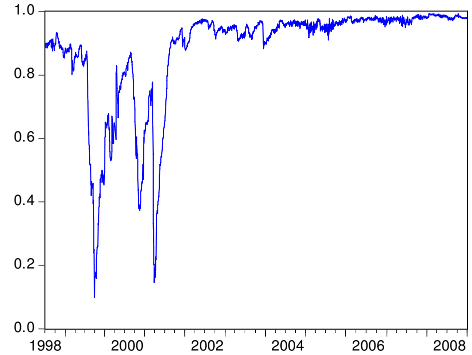


S&P CNX Nifty Index: Singapore and India

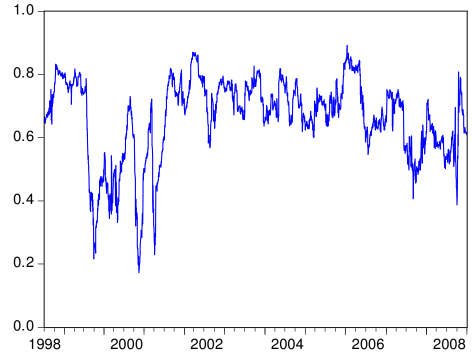
Figure 9: Time-Varying Correlations between Daily Futures Market Returns for Financial Futures



Nikkei 225: U.S. and Singapore



Nikkei 225: Singapore and Japan



Nikkei 225: U.S. and Japan

Vita

Naseem M. Al Rahahleh was born in Sham, Jordan. He received his Bachelor of Economics from Yarmouk University in 1994. After receiving his Master of Economics from Yarmouk University in 1997, he worked for seven years in a USAID funded project operating in the Jordanian Ministry of Planning dealing extensively with the private sector. While he was a director of that project, he published the *Jordan's Competitiveness Book: Confronting the Competitiveness Challenge* with his team members. He enrolled in doctor program at the University of New Orleans in August 2005, where he received his Master of Science in Financial Economics in 2007 and his Ph.D. in Financial Economics in spring of 2009. While at the University of New Orleans, he received the Toussaint Hocevar Memorial Award for Outstanding Ph.D. Candidate in Financial Economics.